USING TELE-REHABILITATION TO ADDRESS EXECUTIVE DYSFUNCTION AND TO PROMOTE COMMUNITY INTEGRATION AFTER TRAUMATIC BRAIN INJURY: A PILOT STUDY

By

Edith Man Wai Ng

A thesis submitted in conformity with the requirements for the degree of Master’s of Science

Graduate Department of Rehabilitation Science
University of Toronto

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ABSTRACT

Executive dysfunction can affect community integration in adults with traumatic brain injury (TBI). The Cognitive Orientation to daily Occupational Performance (CO-OP) approach has shown some promise in promoting functional improvements in adults with executive dysfunctions post TBI. However, access to rehabilitation is often limited especially in rural communities. This study aimed to (1) investigate the feasibility of administering the CO-OP approach in a tele-rehabilitation format and (2) examine its impact on community integration and executive dysfunction. A pilot series of 3 case studies was conducted. Participants identified 5 goals; 3 were trained and 2 were untrained to allow examination of transfer. Outcome measures included the Canadian Occupational Performance Measure, the Mayo-Portland Adaptability Inventory-4 Participation Index, and the Dysexecutive Questionnaire. Descriptive analyses demonstrated goal achievement and transfer, suggesting it is feasible to implement the CO-OP approach in a tele-rehabilitation format. Community integration and executive dysfunction behaviours also showed trends towards improvement.

Keywords: brain injury, executive function, tele-rehabilitation, community integration
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<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ABI</td>
<td>Acquired Brain Injury</td>
</tr>
<tr>
<td>APS</td>
<td>Attention and Problem Solving Group Approach</td>
</tr>
<tr>
<td>BADS</td>
<td>Behavioural Assessment of Dysexecutive Syndrome</td>
</tr>
<tr>
<td>BP</td>
<td>Behavioural Practice</td>
</tr>
<tr>
<td>CBT</td>
<td>Cognitive Behavioural Therapy</td>
</tr>
<tr>
<td>CI</td>
<td>Confidence Interval</td>
</tr>
<tr>
<td>CO-OP</td>
<td>Cognitive Orientation to daily Occupational Performance</td>
</tr>
<tr>
<td>COPM</td>
<td>Canadian Occupational Performance Measure</td>
</tr>
<tr>
<td>DEX</td>
<td>Dysexecutive Questionnaire</td>
</tr>
<tr>
<td>DPA</td>
<td>Dynamic Performance Analysis</td>
</tr>
<tr>
<td>F-Up</td>
<td>Follow-Up</td>
</tr>
<tr>
<td>G</td>
<td>Group</td>
</tr>
<tr>
<td>GMT</td>
<td>Goal Management Training</td>
</tr>
<tr>
<td>HVLT-R</td>
<td>Hopkins Verbal Learning Test-Revised</td>
</tr>
<tr>
<td>I</td>
<td>Importance Rating (on COPM)</td>
</tr>
<tr>
<td>IADL</td>
<td>Instrumental Activities Of Daily Living</td>
</tr>
<tr>
<td>IE</td>
<td>Information Education</td>
</tr>
<tr>
<td>ISMT</td>
<td>Interactive Strategy Modelling Training</td>
</tr>
<tr>
<td>LSQ</td>
<td>Life Space Questionnaire</td>
</tr>
<tr>
<td>McST</td>
<td>Meta-cognitive Skills Training</td>
</tr>
<tr>
<td>MMET</td>
<td>Modified Multiple Errands Task</td>
</tr>
<tr>
<td>MPAI-4</td>
<td>Mayo-Portland Adaptability Inventory</td>
</tr>
<tr>
<td>MPAI-4-P</td>
<td>Mayo-Portland Adaptability Inventory, Participation Index</td>
</tr>
<tr>
<td>MSET</td>
<td>Modified Six Elements Test</td>
</tr>
<tr>
<td>MST</td>
<td>Motor Skills Training</td>
</tr>
<tr>
<td>MT</td>
<td>Memory Training</td>
</tr>
<tr>
<td>MTED</td>
<td>Multifaceted Treatment of Executive Dysfunction</td>
</tr>
<tr>
<td>N/A</td>
<td>Not Available</td>
</tr>
<tr>
<td>NMT</td>
<td>Neurologic Music Therapy</td>
</tr>
<tr>
<td>OTMT</td>
<td>Oral Trail Making Test</td>
</tr>
<tr>
<td>P</td>
<td>Participant</td>
</tr>
<tr>
<td>PASAT</td>
<td>Paced Auditory Serial Addition Task</td>
</tr>
<tr>
<td>PST</td>
<td>Problem Solving Training</td>
</tr>
<tr>
<td>QOL</td>
<td>Flanagan’s Quality of Life Scale</td>
</tr>
<tr>
<td>RAPS</td>
<td>Rapid Assessment of Problem solving Test</td>
</tr>
<tr>
<td>RCT</td>
<td>Randomized Control Trial</td>
</tr>
<tr>
<td>SIT</td>
<td>Self Instructional Training</td>
</tr>
<tr>
<td>SMS</td>
<td>Strategic Management Simulation</td>
</tr>
<tr>
<td>SO</td>
<td>Significant Other</td>
</tr>
</tbody>
</table>
LIST OF SYMBOLS

\( t \) \hspace{0.5cm} t\text{-value} \\
\( df \) \hspace{0.5cm} Degree of freedom \\
\( p \) \hspace{0.5cm} p\text{-value} \\
\( P \) \hspace{0.5cm} Percentile rank \\
\( \% \) \hspace{0.5cm} Percent \\
\( n \) \hspace{0.5cm} Number of cases \\
\( \& \) \hspace{0.5cm} And \\
\( \copyright \) \hspace{0.5cm} Copyright \\
\( \text{TM} \) \hspace{0.5cm} Trademark \\
\( \text{UIN} \) \hspace{0.5cm} Degree of unmet needs (on QOL) \\
\( X \) \hspace{0.5cm} Importance rating (on QOL) \\
\( Z \) \hspace{0.5cm} Maximum possible attainment rating (on QOL) \\
\( Y \) \hspace{0.5cm} Actual attainment rating (on QOL) \\
\( i \) \hspace{0.5cm} The measured area (on QOL)
CHAPTER 1: INTRODUCTION

The purpose of this study was to investigate whether a meta-cognitive approach for executive dysfunction can be used effectively in a tele-rehabilitation format to promote community integration and to address executive dysfunction with adults post traumatic brain injury (TBI). Executive dysfunction has been described as a “primary disability” and “a major barrier to community integration” for individuals with TBI (Gordon, Cantor, Ashman, & Brown, 2006, p. 156). Greater executive dysfunction has been found to be associated with poorer community integration and, in general, poorer rehabilitation outcomes (Hanks, Rapport, Millis, & Deshpande, 1999; Reid-Arndt, Nehl, & Hinkebein, 2007). Therefore, identifying interventions to help manage executive dysfunction and its consequences is critical.

However, access to therapy is often limited especially in rural communities (Keightley et al., 2009; Laurent, 2002). To bridge this gap, the use of information technologies to link patients and health care providers has been recommended (Romanow, 2002). In this study, Internet-based videoconferencing software was used to deliver meta-cognitive training (the Cognitive Orientation to daily Occupational Performance (CO-OP) approach) in a remote format. To our knowledge, this is the first study to implement a meta-cognitive training program that addresses executive dysfunction with adults living with TBI through a tele-rehabilitation format.

This thesis is organized in a manuscript format. Chapter 2 presents a two-part literature review to provide background information for this study. The first part aimed to explore the existing evidence on the intervention approaches for executive dysfunction including the maintenance and generalization and / or transfer of the intervention outcomes.
for adults with TBI. Part 2 aimed to explore the existing evidence in the use of tele-
rehabilitation-based intervention with adults with TBI and the individuals’ receptiveness to
receive remote therapy.

Chapter 3 is written in the required manuscript format for submission to the journal
Neuropsychological Rehabilitation. This chapter presents the findings of a series of 3 case
studies that (1) explored the feasibility of administering the CO-OP approach in a tele-
rehabilitation format; and (2) examined if the CO-OP approach in its tele-rehabilitation
format could promote community integration and help manage executive dysfunction.

A discussion of the findings from the information presented in chapter 2 and 3 along
with the study’s limitations, implications, and future directions are presented in chapter 4.
Chapter 5 presents a brief conclusion to the study and its key findings.
CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter provides the background information on two main areas: first, the rehabilitation of executive dysfunction and second, the use of tele-rehabilitation with adults with traumatic brain injuries. Traumatic brain injuries (TBI) can lead to various physical, cognitive, communication, and psychosocial issues that can have a devastating impact on individuals’ lives. One of the common cognitive problems is executive dysfunction. Executive function is an integration of various cognitive skills and the disruption of this integration post-TBI is often associated with psychosocial and functional limitations. The multitude of problems that may be experienced by individuals with TBI due to executive dysfunction can become major barriers to community integration. Greater executive dysfunction has been found to be associated with poorer community integration and is a predictor of worse rehabilitation outcome (Gordon, Cantor, Ashman, & Brown, 2006; Hanks, Rapport, Millis, & Deshpande, 1999; Reid-Arndt, Nehl, & Hinkebein, 2007). Therefore, to truly address community integration and to promote recovery, it is important to look into the management of executive dysfunction.

Various approaches have been explored for the rehabilitation of executive dysfunction and practice guidelines have been suggested (Cicerone et al., 2000, 2005). However, despite the increasing amount of evidence available to advance rehabilitation, access to rehabilitation interventions is often limited especially in rural communities (Keightley et al., 2009). The use of information technologies to link patients and health care providers has been identified as a potential option to enhance service access (Romanow, 2002). This chapter presents findings from a 2-part literature review. The first part aims to
explore the rehabilitation approaches that have been used to address executive dysfunctions.

The second part aims to look at the current evidence available on the use of tele-rehabilitation-based interventions with adults with TBI.

2.2 The Literature Review of the Rehabilitation of Executive Dysfunction

2.2.1 The Rehabilitation of Executive Dysfunctions

Executive function has been described as the ability to set goals, formulate plans, execute the plans, and to monitor and modify the plans based on changing circumstances often over a long period of time (Burgess & Alderman, 2004). Cicerone et al. (2000) defined executive function as “integrative cognitive processes that determine goal-directed and purposeful behaviour” and which include “the ability to formulate goals; to initiate behaviours; to anticipate consequences of action; to plan and organize behaviour according to spatial, temporal, topical, or logical sequences; and to monitor and adapt behaviour to fit a particular task or context” (p.1605). These integrated cognitive processes of executive function allow individuals to identify problems or set goals, to formulate and organize plans to correct these problems or achieve these goals, and to execute the plans under changing and often distracting circumstances. It is these processes that are the focus of this literature review. In this review, these executive cognitive processes were refined to include problem solving, planning, organizing, and multi-tasking. Other factors such as self-awareness, family support, and psychological well-being may also affect executive functions and goal achievement (Evans, 2009; Lezak, 1993); however, these influential factors were not included in this review. Only studies that examined interventions for problem solving, planning, organizing, and multi-tasking were included.
A systematic review on the rehabilitation of executive dysfunctions up to 2004 was published by Kennedy et al. in 2008. Their review, which examined interventions for problem solving, planning, organizing, and multi-tasking and included intervention studies on children and adults, identified 15 articles. They identified three types of interventions: meta-cognitive strategy instruction (10 studies), training strategic thinking (3 studies), and training multi-tasking (1 study) or doing two things at once (1 study). They concluded that there is compelling evidence showing that step-by-step meta-cognitive strategy instruction improves problem solving for personally relevant activities or situations. Therefore, they recommended using meta-cognitive strategy instruction as a practice standard for young to middle aged adults with TBI to address issues in problem solving, planning, and organization (Kennedy et al., 2008).

The literature review reported here used similar criteria and a similar structure to that of Kennedy et al. (2008). However, for the purpose of this literature review, only intervention studies directed at adults with TBI were included. The term “head injury” and, where possible, the plural forms of the keywords were added to the literature search to promote inclusion of potentially relevant materials. The question that this review aimed to answer was: what is the current evidence on the intervention approaches for executive dysfunction for adults with TBI that promote maintenance and generalization and / or transfer of outcome?

Due to the slight change in the list of keywords from that of Kennedy et al. (2008), all publications available through the University of Toronto electronic library system from the earliest to the most recent articles available up to July 26, 2010 were included in the current literature review. The search was completed on the following databases: MEDLINE (earliest
from 1950), PsycINFO (earliest from 1806), Cumulative Index to Nursing and Allied Health Literature (CINAHL) (earliest from 1981), and Education Resources Information Center (ERIC) (earliest from 1966). These databases were selected to capture literature from the fields of education, psychology, rehabilitation, allied health, nursing, and medicine. Inclusion and exclusion criteria were followed to guide the screening of the studies found.

2.2.2 Inclusion and Exclusion Criteria

Only intervention studies on the rehabilitation of problem solving, planning, organizing, and multi-tasking were included in this review. Intervention studies that did not specifically target executive functions were not included. Studies that addressed the underlining cognitive-perceptual skills such as memory, attention, working memory, neglect, and perception were not included. In addition, studies that focused on potentially influential factors such as communication, self-awareness, self-regulation, social-cognition, emotion, coping, and behavioural control but that did not involve interventions to address problem solving, planning, organizing, or multi-tasking were excluded.

To be included in this review, the intervention studies had to include isolated interventions specifically defined for problem solving, planning, organizing, and / or multi-tasking, that were directly implemented with adults 19 years old or older with TBI. Studies also had to include objective outcome measures. Review papers and non-intervention studies were not included. Non-intervention studies that involved the examination of theoretical approaches, descriptive studies including case illustrations without clear objective outcome measures, pharmaceutical, cellular, and animal studies were also excluded.

This review only included articles from peer-reviewed journals that were published in English. Approaches published in books were not included.
2.2.3 The Keywords Used and The Search Outcome

The keywords selected aimed to provide a comprehensive coverage of intervention studies that addressed problem solving, planning, organizing, and multi-tasking. As self-awareness and self-regulation are often associated with one’s ability to plan and problem solve, these terms were included in the list of keywords used. However, as discussed in the inclusion and exclusion criteria, articles that solely addressed self-awareness and self-regulation were not included. The same set of keywords was used for the literature searches in each of the databases: MEDLINE, PsycINFO, CINAHL, and ERIC. The set of keywords used was:

“(traumatic brain injury or traumatic brain injuries or brain injury or brain injuries or closed head injury or closed head injuries or head injury or head injuries or head trauma) and (executive function or executive functions or executive dysfunction or executive dysfunctions or meta-cognition or awareness or self-awareness or planning or problem solving or self-monitoring or self-control or strategies or strategy or self-instruction or self-regulation or meta-memory or goals or goal or reasoning) and (intervention or treatment or compensation or therapy or training or remediation or rehabilitation).”

The database searches were restricted to human studies that included adults age 19 years and older where possible. The search resulted in a total of 2209 articles, where 1635 articles were from MEDLINE and PsycINFO, 142 articles were from ERIC, and 429 articles were from CINAHL. All articles were screened using the inclusion and exclusion criteria and duplications were removed. This process resulted in 32 articles addressing problem solving, planning, organizing, and multi-tasking that met the criteria and were included in this review. These articles are categorized and discussed based on their intervention formats in this chapter and they are also summarized in table format in Appendices A to E.
2.2.4 An Overview of Study Designs and Participants’ Characteristics

The 32 studies varied in study designs, sample size and characteristics, and the types of intervention examined. A quarter of the studies (8) were randomized control trials (RCTs) studies, 11 were single-case design studies with control and / or comparison groups, and 13 were single-case studies that did not have control groups. Slightly over half (19 or 59%) of the studies included follow-up in their designs, which ranged from 4-weeks post intervention (Stablum, Umilta, Mazzoldi, Pastore, & Magon, 2007) to 1-year post intervention (Walker, 2002).

The sample size varied from N=1 (Cicerone & Wood, 1987; Satish, Streufert, & Eslinger, 2008; Turkstra & Flora, 2002; von Cramon & Matthes-von Cramon, 1994; Walker, 2002) to N=103 (Man, Soong, Tam, & Hui-Chan, 2006c). Most of the studies included individuals that were at least 1-year post injury. Five studies included individuals with an onset date of less than 1-year post injury (Chen, Thomas, Glueckauf, & Bracy, 1997; Fasotti, Kovacs, Eling, & Brouwer, 2000; Fong & Howie, 2009; Stablum, Umilta, Mogentale, Carlan, & Guerrini, 2000; Stablum et al., 2007; von Cramon & Matthes-von Cramon, 1994). Time since injury varied from 7 months (von Cramon & Matthes-von Cramon, 1994) to 23 years in a single-case study (Turkstra & Flora, 2002). The oldest average age reported in the treatment groups was 52 (Thaut et al., 2009). Approximately two thirds of the participants in these studies were males.

2.2.5 An Overview of the Approaches

The intervention approaches were mostly delivered in individual sessions. Only 7 studies delivered their interventions in a group format. Two of these studies provided an option to do individual sessions if the participants showed significant signs of apathy or lack of effort
and could not tolerate group settings (Fong & Howie, 2009; von Cramon, Matthes-von Cramon, & Mai, 1991). Most of the group interventions involved explicit problem solving and strategy training (Foxx et al., 1988; Foxx, Martella, & Marchand-Martella, 1989; Miotto, Evans, de Lucia, & Scaff, 2009; Rath, Simon, Langenbahn, Sherr, & Diller, 2003). The duration and frequency of the interventions varied from a single 1-hour individual session (Levine et al., 2000) to weekly individual sessions for 12 months (von Cramon & Matthes-von Cramon, 1994). The interventions also varied in the aspects of executive functions that were targeted and in the intervention approaches that were used. There were also similarities among these approaches.

Most of the strategies aimed to teach and followed systematic processes to guide problem solving and planning. Generalization and transfer of learning were discussed in some of the articles, however, the definitions of these terms were not always clear. In this paper, the definitions from Polatajko and Mandich (2004) are used. Generalization of learning is defined as the ability to apply one’s newly learned skills in real life situations without the help of the therapist. Transfer of learning is defined as the ability to adapt and transfer the learned skills or strategies to meet the demands of other new skills that are encountered in everyday life (Polatajko & Mandich, 2004, p. 48).

Four studies aimed to train particular skills related to aspects of executive functions through performing a given task or cognitive training (Chen et al., 1997; Stablum et al., 2000, 2007; Thaut et al., 2009). The 4 skill training studies are reviewed here and they are also summarized in a chart in Appendix A.
2.2.6 Skill Training Studies Related to Executive Dysfunctions

Neurologic music therapy was used in one study. It consisted of one 30-minute session that was reported to train decision making, problem solving, comprehension, and reasoning. The training involved following 2 rapidly alternating musical cues in an interactive musical group to train alternating attention and comprehension of the situation at hand. When compared to a control group who did not receive the training, improvement was reported on mental flexibility and self-efficacy related to executive functions. Maintenance and how this training may have impacted everyday activities were not reported (Thaut et al., 2009).

Two studies examined dual-task performances using computer-based training (Stabulm et al., 2000, 2007). During training, 2 forms of stimuli would appear on the computer monitor and the participants had to respond to each stimulus shown accordingly. The treatment group was found to have reached a similar performance level as the healthy control group after 1 week of daily training (5 sessions) and outcomes were maintained during follow-up in both studies. Improvement on the Paced Auditory Serial Addition Task (PASAT) (Stabulm et al., 2000), Dual Task, and Behavioural Assessment of Dysexecutive Syndrome (BADS) were found post training (Stabulm et al., 2007). Transfer of skills onto everyday activities was suggested through an anecdotal report from one participant who reported improvement in his ability to play card games (Stabulm et al., 2000).

Computer-based training program was also used in another study (Chen et al., 1997). In this cognitive rehabilitation program, basic cognitive processes were trained first then followed by more complex functional skills training. Although a detailed description of the program was not provided, it was said to remediate four cognitive functions, one of which was problem solving. The computer-assisted rehabilitation was compared with conventional
therapy. The two groups varied significantly in their time post-injury and in the duration of treatment received. The mean time post injury for the comparison and the experimental groups were 6.8 and 15.9 months, respectively. The experimental group received an average of 14.1 months of intervention to achieve similar outcomes to the comparison group who received 3.03 months of intervention. The authors suggested that the gains made in the experimental group would support future studies of the computer program. Although more research will be needed to further examine the effectiveness of the program, the outcome of this study may suggest that improvement in cognitive functions may still be possible at 15.9 months post injury although a longer duration of intervention may be needed to reach similar outcomes compared to individuals more recently injured. However, the lack of details regarding the training programs limits the ability to truly examine and compare the intervention provided in this study with other studies.

All 4 skill-based training studies showed improvement post-training. However, potential transfer of learning was only reported through an anecdotal report in one study.

2.2.7 Strategy-Based Training Approaches for Executive Dysfunctions

The remaining 28 studies examined approaches that trained internal and / or external strategies to manage the participants’ executive dysfunctions. The studies are grouped based on how the strategy training was structured: (1) single-element strategy training studies, (2) multi-element strategy training studies, (3) activity-specific strategy training studies, and (4) scenario-based problem solving training.

Single-element strategy training includes intervention approaches in which a particular strategy is individually examined. Single-element strategy interventions may be used as components of multi-element strategies. Multi-element strategy training consists of a
mixture of global and/or domain-specific strategies. Global strategies are over-arching strategies that are applied across different situations without further adaptation (Polatajko & Mandich, 2004). Domain-specific strategies are strategies that are applied to task or environment specific situations, such as an activity-based checklist to prompt task completion (Polatajko & Mandich, 2004). Some studies examined the use of strategies that address executive dysfunction related behaviours during specific tasks. These studies are grouped under activity-specific strategy training studies. Lastly, the remaining studies look at scenario-based problem solving interventions. These approaches use a variety of scenarios or “story-frames” to which the participants are asked to respond to as part of their training.

These four groups of studies are presented here in this order: (1) single-element strategy training studies, (2) multi-element strategy training studies, (3) activity-specific strategy training studies, and (4) scenario-based problem solving training.

2.2.7.1 Single-Element Strategy Training Studies

Five single-element strategy training studies that explored a specific technique to promote problem solving, planning, and multi-tasking are summarized in Appendix B. Two studies specifically aimed to address transfer as part of their interventions. Both studies examined the use of self-instruction training and one of these was the earliest strategy-based intervention study found in this literature review (Cicerone & Wood, 1987). The process involved 3 stages: (1) speaking aloud, (2) whispering to self, and (3) talking silently to self, which the participant practiced in the context of the modified Tower of London task. This task involves moving 3 coloured beads between 3 pegs from a specified beginning position to reach a specified end position while following given rules and restrictions. Measurements
were taken before and after each stage of the self-instruction training. Off-task behaviours and incorrect moves decreased with self-instruction training and were maintained at 4 months follow-up. However, improvement in everyday behaviours was reported only after an additional training program was implemented to explicitly facilitate transfer of learning into everyday life.

The second study on self-instruction training was a multiple baseline study with 5 participants (Cicerone & Giacino, 1992). The 3 stages implemented in the study reported by Cicerone and Wood (1987) were re-examined while the modified Tower of London task was completed. Most participants had reduced errors and off-task behaviours after training and these were maintained at follow-up. One participant did not show gains from the self-instruction training and was further trained using a self-monitoring intervention provided in an ABAB study format. Although he showed increased ability to self-recognize and self-correct errors and errors were reduced when the self-monitoring intervention was used, errors returned to pre-intervention level once the intervention was removed. From the 4 individuals that improved with self-instruction training, 2 received additional training to promote transfer of learning into everyday life. The 2 individuals who received this additional training were the only participants that reported an increase in the spontaneous use of the techniques and greater behavioural regulation in untrained real life situations.

Another single-element strategy training study specifically examined the generation of plans post TBI. The study examined the use of autobiographical memory by thinking of specific times and places where the individuals may have completed similar activities in the past to help them plan for current situations (Hewitt, Evans, & Dritschel, 2006). During the training, education on the benefit of autobiographical memory was first provided and the
participants were then trained to use this type of memory to generate plans for given situations, for example, planning for a holiday. Improvement was reported, following the 30-minute training session, on the effectiveness of the plans and the use of specific memories in the verbalized plans. Maintenance and how this strategy might have generalized to real life planning were not reported.

For some individuals, the plans they formulate may appear effective, but the execution of these plans in real life may be interrupted and forgotten especially with the distraction of other activities and everyday responsibilities. Two studies have looked specifically at the application of the strategy of “stop and think” in relation to how it may provide an interruption to everyday distracter tasks to redirect the attention to the execution of planned specified activity (Fish et al., 2007; Manly, Hawkins, Evans, Woldt, & Robertson, 2002). One of these studies added tones that were played at different times during the completion of the Hotel Task. Here, participants were asked to try parts of all 6 sub-tasks within a 15-minute period (Manly et al., 2002). The participants were told that the tone might be useful to remind them to think of what they were doing although no response was expected of them when the tone was played. The participants improved in task performance to a similar level to that of the healthy control group when the tones were added.

In the second study, a phone message that simply read, “STOP”, was used to prompt an “executive review” to see if it would enhance accuracy in following a schedule to make phone calls during the day (Fish et al., 2007). In this study, specific training was completed including education regarding action slips and prospective memory. Through the use of errorless learning, the participants were taught the schedule of the phone calls and to associate the message “STOP” with “when I get a text message saying STOP! I should stop
what I was doing and think about my current goal” (Fish et al., 2007, p. 1323). Performance on the cued days (days when the text messages were received) was better than on the un-cued days (days when the message was not received); however, this improved performance was comparable to baseline performance. It was suggested that the high baseline performance might have been related to the errorless learning used to train the recall of the call schedule and / or due to the novelty of the task. Given the drop in performance with the removal of the cues, the continuous use of external prompts to elicit “executive review” may be required for its effect to be maintained. However, its success in long term use and how or if the use of the cues may enhance everyday performance beyond remembering to make phone calls will need to be further examined.

2.2.7.2 Multi-Element Strategy Training Studies

Eleven multi-element strategy training studies are included in this review. They are discussed here and summarized in Appendix C. A few of the single-element strategy approaches discussed are incorporated as techniques or steps within some of the multi-element strategy approaches.

Self-instruction was used to train a component of the 3-stage process of Time Pressure Management (Fasotti et al., 2000). The first stage of training involved an introduction to build awareness of the relationship between mental slowness and task performance. The second stage involved using the self-instructional method to learn the strategy that was called “let me give myself enough time.” The strategy consisted of 4 steps: (1) determine if there are 2 or more tasks to be done at the same time; (2) make a plan; (3) make an emergency plan in case overwhelming time pressure is experienced; and (4) monitoring and determining if the plans are ready and to implement them. During training,
the participants had to recall 2 types of stories presented from a tape player. The final and third stage aimed to promote application and maintenance by completing similar tasks as in stage two but under distraction. The comparison group received generic suggestions that included: stay focused, remember the main theme, do not get distracted by internal and external distractions, and try to imagine what was said. Improved ability to manage the tasks was reported in both groups and these gains were maintained at 6-months follow-up. Although improvement in memory and attention tests was found only in the treatment group, Time Pressure Management did not appear to be more effective in task performance than education or receiving suggestions on management techniques alone.

Another multi-element strategy training is the Problem solving Training (PST) (von Cramon et al., 1991). PST aims to provide step-by-step strategy and techniques to manage multistage problems by breaking them into smaller steps. Five aspects of problem solving behaviours were targeted and taught in the PST: (1) problem orientation, (2) problem definition and formulation, (3) generating alternatives, (4) decision-making, and (5) solution verification where monitoring to recognize and self-correct errors was addressed. Everyday activities were used to train application of the strategy. Emphasis was also placed on the way the trainers communicated and interacted with the participants. The trainers could only interfere if it was necessary and they had to provide cues in a graded manner. Cues were faded over time to promote internalization. Improvement in various tests including those related to problem solving, reasoning, and planning was reported. Although follow-up was not completed, transfer of the skills learned was suggested based on the improvement found in the behavioural ratings.
A high involvement goal setting group was compared with a low involvement goal setting group to measure the impact on goal achievement (Webb & Glueckauf, 1994). The high involvement group received training on goal orientation and education, goal setting, and 8 weeks of goal monitoring training. The low involvement group only identified their goals and did not receive any goal education or self-monitoring training, however weekly meetings were held where they reported on their goal progress. Although both groups improved after the intervention, only the high involvement group maintained their goal achievement at 2-months follow-up. The importance of goal setting to promote positive change for individuals with post brain injury has been documented and studied (Gauggel & Billino, 2002; Hart & Evans, 2006). However, the emphasis here is that setting goals may not be sufficient for adults with TBI, rather understanding the importance of goals and the active involvement in goal setting and self-monitoring may promote more sustainable outcome.

Goal setting and self-monitoring were also reinforced in the Goal Management Training (GMT) approach that was examined in an RCT study (Levine et al., 2000). The first stage of this training is “stop,” the concept that was tested in the single-element strategy training discussed earlier in this chapter (Fish et al., 2007; Manly et al., 2002). There were 5 stages in the GMT: (1) “Stop” and orient to the current situation, (2) define the goal, (3) formulate the plans, (4) learn and execute the steps, and (5) check. The trainer provided instruction and incorporated examples that were relevant to the participants in an individual format. The participant would then apply the approach to a real life task at the end of the session. They compared GMT with Motor Skills Training. Reduction in errors was reported after the 1-hour GMT session but not after the Motor Skills Training. Follow-up data and
indication of transfer of learning into everyday life were not provided; however, this short 1-hour session did lead to improvement in untrained paper-and-pencil tests.

In the same article, GMT was also examined in a case study with a 35-years old female with meningo-encephalitis (Levine et al., 2000). Although this participant did not have TBI, the case is presented here because training was directly applied to everyday task, meal preparation. Improvement was reported in her performance during meal preparation and in paper-and-pencil tasks and the gains were maintained at follow-up. The participant indicated successful use of the GMT principles in daily life suggesting transfer of learning. This non-TBI case study showed that GMT could improve performance in everyday activities. Replication of the study with individuals with TBI may be beneficial, and the sustainable gains and potential transfer of the techniques found in this study is promising. The participant reported using the checklist and found cuing herself to “stop and think” to be helpful. Other studies have also incorporated a component of “stop” in their approaches to influence planning, organizing, and performance.

“Stop and think” was also used in the problem solving strategy training that aimed to provide a structured format to assess and manage problems (Rath et al., 2003). The approach was taught in a group format and it consisted of 2 main components: problem-orientation and problem solving skills. Emotional self-regulation was a key focus of the problem orientation component. The participants were told to think through the problem starting with “stop and think” in which the participants would ask themselves “clear-thinking questions” to guide them through each step. Role-play and various behavioural techniques were used to help participants to recognize and manage their emotional reactions related to the problem situations. The second component of the training - problem solving skills - involved learning
the following steps: defining the problem, identifying and refining the goals, generating options and alternatives, evaluating, and following-up. The participants would learn to compare the eventual outcome with the anticipated consequence, and to repeat the cycle of the problem solving process if necessary. Real life examples were used during role-plays and practice. The comparison group received cognitive remediation training and they discussed their psychosocial issues during the sessions. Problem solving and problem solving self-appraisal improved and were maintained at 6-months follow-up in the experimental group but not in the comparison group. However, fewer cognitive and somatic symptoms were reported after the psychosocial and cognitive remediation training. The combination of self-regulation management and problem solving strategy training appeared to be effective in promoting self-confidence and problem solving skills. Although improved symptoms were reported in the comparison group, problem solving skills only improved with specific strategy training. There also was an anecdotal report regarding the use of the strategies learned in everyday life.

Applying strategies to address everyday activities that were limited due to executive dysfunctions in planning, organizing, flexibility, and self-monitoring, were examined in one case study (Walker, 2002). The training began with the identification of problem areas in the person’s daily life. The intervention aimed to build awareness and understanding of factors that were limiting functions, develop compensatory strategies to address different cognitive issues including executive dysfunctions, and apply these onto single and then multiple activities within their individual contexts. The specific strategy or steps that were followed during training were: (1) identification of the problem activity, (2) identify the steps within the activity, (3) analyze the steps, (4) transfer the steps onto index cards, (5) incorporate the
compensatory strategies developed, (6) execute the steps in real life settings, and (7) self-evaluation and self-monitoring. Guidance and instructions were given by the therapist to assist the participant through each step of the training. All of the 10 IADL tasks that were reported to have unsuccessful performance at pre-intervention were successfully performed after the training. Maintenance and the transfer of the strategies learned onto other untrained situations such as in the work place were reported.

Everyday activities were often used either during training and/or as part of homework to promote generalization and transfer of learning in all of the multi-element strategy training studies especially in the more recently published articles. There were 5 articles that used multi-element strategy training in 2009 and 2010. Maintenance was measured in all 5 studies and only one did not report on the potential transfer of outcome.

Homework was used to promote generalization and transfer of the strategies learned beyond the sessions in the meta-components of problem solving training (Fong & Howie, 2009). The program was delivered in a group format and it was implemented over 15 weeks. The problem solving sessions were preceded by attention training. The program emphasized a change from using linguistic information to spatial information when solving problems. Components of problem solving were taught one by one each week. These components included: (1) defining the problem, (2) planning, (3) problem representation via visualization exercise, and (4) self-monitoring including prediction of consequences. The comparison group did not receive the experimental training and both groups received conventional therapy. Gains were reported in both groups but greater gains were reported in the experimental group in the Metacomponential Interview, which measured correctness of responses and the use of meta-components. The authors suggested the use of meta-
componential strategy to be effective. However, transfer of the strategy into everyday performance was not found.

The Attention and Problem Solving Group Approach (APS) uses a template to guide the participants to apply its step-by-step process as a whole to solve both hypothetical and everyday problems (Miotto et al., 2009). This approach aimed to target problem awareness, monitoring and evaluation, plan development, and plan initiation and implementation. The problem solving framework that the participants were instructed to use consisted of the following steps: (1) identify the problem, (2) stop, think and clarify the min goal, (3) identify the solution(s), (4) decide on the solution, (5) create a plan, (6) carry out the plan, and (7) do an overall evaluation. After the training, improvement in planning was found and the caregivers, but not the participants, reported a decrease of executive symptoms. The improvements were maintained and an increased employment rate was reported at follow-up.

The benefit of strategy-based training was also reported in an RCT study that examined the Multifaceted Treatment of Executive Dysfunction (Spikman, Boelen, Lamberts, Brouwer, & Fasotti, 2010). This approach was based on the GMT (Levine et al., 2000) and the PST (von Cramon et al., 1991). Three stages were involved in this approach: (1) information and awareness training involving psycho-educative sessions to build awareness and motivation; (2) goal setting and planning training where goals and planning skills were targeting based on the participants’ everyday difficulties related to executive dysfunctions; and (3) initiation, execution, and regulation or monitoring training during which GMT and PST were introduced and used. During training, the strategies were practiced in relations to 3 goals that were set by the participants and they were repeatedly told to use the strategies learned in everyday life to promote generalization and transfer. This
approach was compared with a computer software program that provided repetitive cognitive training on skills the participants chose to complete to reach their 3 individually identified goals. They found the Multifaceted Treatment of Executive Dysfunction led to greater role assumption and goal achievement than the comparison group and that these gains were maintained at follow-up. Both the patients and the caregivers reported a decrease in executive symptoms after either training, but the therapists reported a greater decrease in symptoms after the Multifaceted Treatment of Executive Dysfunction. No change in neuropsychological test outcomes was found after either training program.

The use of participants’ self-identified goals with explicit strategy training was also an important part of the Cognitive Orientation to daily Occupational Performance (CO-OP) approach (Dawson et al., 2009). The strategy that was explicitly taught in the CO-OP approach was Goal-Plan-Do-Check, which was used to apply to goals that the participants self-identified. The participants were also encouraged to use the strategy outside the sessions to promote generalization and transfer of learning. The trainer was instructed to use a “guided discovery” technique to help participants formulate their plans and develop more domain specific strategies during the process. After training, improvement in goal performance and satisfaction was reported for most of the trained and untrained goals. Fewer executive dysfunction symptoms were also reported post training. Improvement was maintained at 3-months follow-up. Transfer of learning was reported based on the improvement made in the untrained everyday performance goals and the decrease in executive dysfunction symptoms that was reported. The “guided discovery” approach and the use of its strategy of Goal-Plan-Do-Check encouraged participants to take on an active
role throughout the process, in which they were guided to develop goals and plans, to self-monitor their progress, and to modify their plans as needed.

To specifically promote transfer of the strategy, a multi-context approach that incorporated the use of meta-cognitive strategies was examined (Toglia, Johnston, Goverover, & Dain, 2010). Sessions were completed twice weekly where the participants learned to breakdown the tasks into steps and to use secondary strategies to address their specific problem areas. Pre-set activities were used initially followed by activities chosen by the participants. The activities were sequenced in a graded manner to promote the ease of transfer of the strategies from one task to the next. The multi-context treatment sessions consisted of: (1) guided anticipation of challenges; (2) guided strategy generation; (3) error discovery, strategy training and mediation, or reinforcement of strategy; (4) self-assessment of challenges and strategy use; and finally (5) structured journal to promote self-reflection and strategy connection. The therapist systematically guided the development and the use of the strategies from task to task. The training focused on the use of successful strategies and not the deficits themselves. The authors suggested that this meta-cognitive training resulted in improved performance in multi-step untrained activities and thus contributed to the transfer of strategies used and the study’s positive outcome. One participant’s outcome measures showed a trend of returning to pre-intervention levels. The authors contributed this to severe unawareness and suggested that longer sessions may have been needed.

Other than the use of strategies in these multi-element strategy training studies, most studies also utilized some form of trainers’ guiding techniques, emphasized participants’ self-monitoring or self-evaluation process, and were goal directed. Transfer of learning and
potential generalization into untrained everyday life activities were demonstrated in most of these studies through their outcome measures or anecdotal report.

2.2.7.3 Activity-Specific Strategy Training Studies

Six studies have looked at the direct application of strategy-based training in specific everyday activities to address executive dysfunction. These studies are reviewed here and are summarized in a chart format in Appendix D. Three of the 6 activity-specific studies examined the application of strategies to address organizing, planning, and problem solving in work settings (Burke, Zencius, Wesolowski, & Doubleday, 1991; Turkstra & Flora, 2002; von Cramon & Matthes-von Cramon, 1994). One study addressed planning and problem solving in the workplace by implementing strategies and training techniques including checklists that were eventually removed, fading feedback, and trainers’ demonstration and modeling (Burke et al., 1991). The participant also recorded his own performance to help monitor his progress. Not only was improvement reported in the trained activities, improvement was also reported in the untrained task suggesting transfer of learning. Enhanced performance was maintained at follow-up. However, transfer of learning beyond the work setting was not reported.

Work performance of a 33-year old medical doctor with TBI was trained using a problem solving approach (von Cramon & Matthes-von Cramon, 1994). Similar to some of the step-by-step strategy-based training, a specific problem solving process was followed: (1) problem identification and problem analysis, (2) generation of hypotheses and decision making, and (3) evaluation of solution. During the training, the participant was explicitly instructed to implement certain strategies for the targeted activities which included accurate diagnoses and report writing. Fading trainer’s guidance and self-instruction techniques were
used as part of training. Improvement in the targeted behaviours was reported. Transfer of learning onto a task that was not explicitly trained was observed but difficulty with other problem solving tasks continued to persist. Follow-up was not reported.

The final activity-based study used compensatory strategy training in work-related performance of a social worker that had TBI (Turkstra & Flora, 2002). Transfer of learning was explicitly trained by using different case scenarios during practice of specific strategies to enhance the interviewing and report writing accuracy and efficiency. Although improvement in performance and security of full-time work were reported at follow-up, transfer of the strategies to the new work setting required further strategy adaptation and training by the first author.

Other activities that were used in the activity-specific strategy training included solving arithmetical text problems (Delazer, Bodner, & Benke, 1998), solving a game (Marshall et al., 2004), and preparing meals (Ownsworth, Quinn, Fleming, Kendall, & Shum, 2010). Participants in the arithmetical text problem study were taught to solve the problem following a given process (Delazer et al., 1998). The participants would first read the question aloud, and then follow a cueing procedure to answer specific prompting questions that were related to problem sentences and problem schema. When the answer was wrong, the trainer would correct the errors and discuss the correct solutions with the participants. The participants were also asked to construct a new question using a similar problem format after the correct solution was identified. Improvement in the number of correctly made steps occurred after the training but training did not affect the accuracy of the answers to the problems. Transfer of learning was not reported. It is interesting to note from this study that the strategy used may enhance the problem solving process but not in solving the problem
itself. This may further emphasize the importance of self-monitoring and error-recognition, and may point to the benefits and challenges of developing and implementing activity-specific strategy training.

Improving problem solving skills was also the target of a board game-based training (Marshall et al., 2004). The trainer modelled the approach for the participant to facilitate their learning to use strategies to solve the presented problem. The trainer and the participant took turns being the problem solver and the instructor. Improvement was reported in the types of questions asked by the participants to solve problems presented in the game. Better scores were also found on a problem solving test and less guessing was reported after training. Maintenance was reported at 1-month follow-up but transfer of learning was not reported.

Self-evaluation or self-monitoring was emphasized in the Meta-cognitive Skills Training used to improve meal preparation performance (Ownsworth et al., 2010). The approach aimed to address self-regulation, including checking for errors, error reduction, and self-correction using role-play, role-reversal, and feedback. Similar to strategies that were used in the other strategy-based training approaches, participants would anticipate, plan, and identify and correct errors. The meta-cognitive skills training resulted in more checks, fewer errors, and more self-corrections than were seen during behavioural practice and this change was maintained during follow-up. Transfer of the strategies onto a novel meal preparation task was reported but functional ratings by the relatives did not indicate significant transfer of learning onto other everyday activities.

These activity-based strategy training approaches all reported positive outcomes and demonstrated their benefits in enhancing performance in the trained activities. Many also
demonstrated potential transfer of learning to similar activities in a similar setting. However, additional intervention to facilitate transfer of strategies to new settings was needed in one study and transfer of learning to other activities in everyday life was not reported.

2.2.7.4 Scenario-based Problem Solving Training Studies

The remaining 6 strategy-based training studies used situational scenarios to train the ability to solve everyday problem situations. Participants in one scenario-based study were trained to identify one solution to 32 problem situations in a group format (Foxx et al., 1988). Improved problem solving behaviours were reported post training, however, participants reported they felt bored and inattentive during the sessions. The approach was modified in another study where the participants took turns to identifying several solutions to each of 48 problem situations (Foxx et al., 1989). In both studies, criterion questions were used to guide the development of solutions. The trainer modelled, provided feedback, and coached the participants during the process, and scorecards as well as money rewards were used to provide feedback to the participants. The criterion questions were: (1) restate the problem, (2) when will the problem be solved, (3) where would you look for help, (4) who would you talk to, and (5) what would you say. Note that the first criterion question was used only in Foxx et al. (1988) study and not in Foxx et al. (1989). Maintenance and transfer of the skills learned in a real life situation that was similar to the trained scenario were reported with the modified approach (Foxx et al., 1989). They concluded that the generation of alternative solutions was more effective than the single solution approach used by Foxx et al. (1988).

Problem solving scenarios were used in a case study that implemented a simulation-based executive cognitive assessment and rehabilitation program (Satish et al., 2008). The computer-based Strategic Management Simulation (SMS) system assesses a person’s
decision-making ability, provides feedback on performance, and helps to develop training to address specific problem areas. The SMS procedure is 4 hours long and it uses different scenarios in which the participant has to assume a given role (for example, a county emergency manager) and make decisions and develop plans based on the continuous flow of information and events. The training process in this case study incorporated education and training that were provided by one of the investigators to guide the participant to understand the errors he had made during the baseline assessment and how they applied to his daily life. The trainer also guided the participant to generate more effective alternate thoughts and actions as he reconsidered the actions that he took when he completed the baseline assessment. Only areas with low scores were specifically trained. This intervention approach, combining computer-based training with direct training provided by the investigator, was reported to have led to improvement in measures of decision-making and other cognitive functions captured through the SMS system. The participant, his family, and his co-workers also reported improvement in everyday functions and behaviours after training.

Although a specific step-by-step process was not explicitly used in most of these scenario-based trainings, trainers guided the participants to generate solutions using structured questions or to consider actions and plans that were made. Trainers’ guidance was also available in the pictorial-based analogical problem solving program that was used in the 3 remaining studies (Man, Soong, Tam, & Hui-Chan, 2006a; Man et al., 2006c; Soong, Tam, Man, & Hui-Chan, 2005). The pictorial-based analogical problem solving program used visual displays and instructions to solve everyday problem scenarios and to draw similarities to help solve new problems. It was assumed that analogical problem solving would not
require reasoning to solve specified problems, and that accuracy could be immediately recognized when the answer was recalled. Role-play, errorless learning, and positive feedback were used to promote motivation and learning during the training. Homework to promote transfer of learning into daily problem solving was provided. Improvement post training was reported in the participants’ problem solving skills including sequential classification, comparison-contrast, identification of effects and solution, and general functional and overall problem solving abilities. Improved performance in instrumental activities of daily living was also reported.

In the RCT study by Man et al. (2006c) and the pilot study by Soong et al. (2005), this problem solving program was delivered in different formats: computer-assisted, therapist-administered, and online interactive computer-assisted format. The programs that were delivered across these groups had the same content. In the on-line group, the therapist shared the screen with the participants, had full control of the program, and was able to provide feedback with the participants as needed. Problem solving skills improved regardless of how the program was delivered. Although self-efficacy in problem solving showed similar levels of improvement as in the pilot study (Soong et al., 2005), self-efficacy only improved in the therapist-assisted group when the program was tested in the RCT study (Man et al., 2006c). However, the improvement in problem solving skills in all 3 groups (therapist-led, computer-led, and the on-line groups) was promising. It shows that in some ways, online therapy may be comparable to the conventional or face-to-face therapy.

2.2.8 The Rehabilitation of Executive Dysfunction Literature Review Summary

From the studies that were reviewed, improving executive functions and more specifically, problem solving skills in everyday function for individuals with TBI has been shown to be
possible. Based on the reviewed studies’ characteristics, the findings from this review may be more applicable for adults with TBI from age 19 to 52 years, males, and individuals who have sustained their injury at least 1 year pre-intervention. Although adults with TBI might have shown gains from the interventions reviewed, transfer of learning beyond the trained settings was more apparent in the multi-element strategy training studies and less in the other formats. However, further research will be beneficial as maintenance and transfer of learning into everyday life were not always measured or reported. Most of these studies were case studies and had small sample sizes. Many of the approaches have not been replicated to further examine their effectiveness. Also, details of the intervention were not always clear. Nonetheless, five areas may be drawn from these 32 studies that included 8 RCT studies for clinicians and researchers to consider when developing and providing rehabilitation to address executive dysfunctions with adults post TBI.

Firstly, how trainers provide the training may be important. Most training programs emphasized the use of specific techniques for the trainers to use. Trainers are often there to model, guide, and provide feedback to facilitate internalization of learning and self-monitoring skills (Dawson et al., 2009; Foxx et al., 1988, 1989; Ownsworth et al., 2010; von Cramon et al., 1991; von Cramon & Matthes-von Cramon, 1994). For example, trainers in Foxx et al. (1988, 1989) used specific guiding questions and provided prompting and feedback to coach the participants to generate solutions in the Problem Solving Skills Training programs. Ownsworth et al. (2010) specified that trainers would give participants opportunities to self-identify errors. In one problem solving training program, participants were only interrupted if determined to be necessary by the trainers (von Cramon et al., 1991). These interaction techniques appear to prompt the participants to generate solutions and to
learn to take ownership of the situation, while trainers were there to guide and facilitate, and not to tell and provide solutions.

Secondly, using variations of everyday activities and focusing on personally relevant goals that the participants actively identify, work towards, and self-monitor were shown to promote goal achievement, better performance, and maintenance. Several studies used participants’ self-identified goals in their training process and suggested maintenance and transfer of learning (Dawson et al., 2009; Miotto et al., 2009; Spikman et al., 2010; Toglia et al., 2010; Walker, 2002; Webb & Glueckauf, 1994).

Thirdly, explicit training to promote transfer of learning has been suggested and has demonstrated to be beneficial in promoting generalization and transfer of learning into everyday activities (Cicerone & Giacino, 1992; Cicerone & Wood, 1987; Dawson et al., 2009; Miotto et al., 2009; Spikman et al., 2010; Toglia et al., 2010). Transfer of the learned strategy was almost always accompanied with an explicit protocol to promote this. The use of diary and homework and guiding the application of the strategies in multiple contexts were often used as techniques to promote generalization and transfer.

Fourthly, task specific strategies may be helpful to promote independence in the targeted task; however, transfer beyond the trained context or tasks may be limited. Some of the activity-based strategy training that reported transfer of learning emphasized self-monitoring, trainers’ guidance, and meta-cognitive training in their programs (Burke et al., 1991; Ownsworth et al., 2010; von Cramon & Matthes-von Cramon, 1994). However, none of these studies reported transfer of learning beyond the trained context. Thus, although task specific strategies may be beneficial to promote functional independence and transfer of
learning in similar activities within the same context, explicit training to promote application of learning in other everyday activities may be necessary.

Finally, meta-cognitive strategy approaches that involved formal strategy-based training and which promote self-monitoring have shown the most promise in enhancing problem solving in everyday life performances. The strategy-based approaches in which the individuals are trained to explicitly identify their problems or goals, formulate plans and strategies, and to self-evaluate and monitor are all forms of meta-cognitive training. Meta-cognition involves having knowledge of the person’s own cognitive skills including factors that may affect them and also strategies that may be useful to make these cognitive processes more efficient. It also involves self-regulation, how the person checks or monitors and regulates or controls his or her behaviours (Ylvisaker & Szekeres, 1989). Most of the studies that have utilized a meta-cognitive training approach have reported positive outcomes (Dawson et al., 2009; Fong & Howie, 2009; Levine et al., 2000; Miotto et al., 2009; Rath et al., 2003; Spikman et al., 2010; Toglia et al., 2010; von Cramon et al., 1991). Participants were often encouraged by trainers to use the strategies taught in everyday life and homework was often used to promote transfer of learning. For individuals with TBI, severe unawareness (Toglia et al., 2010), learning difficulties, and memory issues (Cicerone & Giacino, 1992) have been indicated as factors that may limit the success of meta-cognitive training.

The use of meta-cognitive strategy and self-monitoring training are also reflected in the reviews completed by Cicerone et al. (2000, 2005). Cicerone et al. (2000) recommended “formal problem solving strategies and their application to everyday situations and functional activities” as a practice guideline (p. 1606). A follow-up review by Cicerone et al. (2005)
resulted in the same recommendation and they added that self-instruction and self-monitoring can be used as practice options for the remediation of executive dysfunctions (Cicerone et al., 2005).

Meta-cognitive strategy intervention was also recommended by Kennedy et al. (2008) for the rehabilitation of problem solving, planning, organization, and multi-tasking. Their systematic review led them to conclude that there was a “substantial amount of compelling research” that pointed to the use of step-by-step meta-cognitive strategy training to “improve problem solving, (planning, organizing, and multi-tasking) for personally relevant activities or problem situations” (p. 292).

The reviews by Cicerone et al. (2000, 2005) and Kennedy et al. (2008) recommended the use of formal step-by-step meta-cognitive strategy training in application to the individual’s everyday activities and functional context to address executive dysfunction post brain injury. Based on the current review, it may also be important to consider the trainer-trainee interactions, how the trainee is guided to learn and apply the approach, and also to include explicit training to facilitate the transfer of the strategies in everyday life. These recommendations and considerations will need further investigations to explore what may be the best approach and techniques to apply with which populations and in which circumstances. As Kennedy et al. (2008) recommended, more research is needed to further examine the specific intervention techniques.

One of the intervention techniques discussed that appears to meet the recommendations made by Cicerone et al. (2000, 2005) and Kennedy et al. (2008), and the areas of considerations derived from this review is the Cognitive Orientation to daily Occupational Performance (CO-OP) approach (Polatajko & Mandich, 2004). As discussed
previously, the CO-OP approach explicitly teaches the use of a meta-cognitive strategy, is focused on participants’ self-identified goals, uses trainers to guide discovery to facilitate learning, and explicitly trains transfer through various means. The CO-OP approach was found to positively relate to goal achievement, maintenance, and transfer of learning. In Dawson et al. (2009), the CO-OP training was provided in a face-to-face format in the participants’ homes. However, a face-to-face format is not always feasible for survivors with TBI, especially for individuals who live in the rural communities. This limitation may be related to different factors such as funding, transportation, availability of services, and environmental accessibility (Keightley et al., 2009; Sample & Darragh, 1998). Internet-based service delivery format has been suggested as a possible alternative. At the time of this literature review, the tele-analogy-based problem solving programs used in the studies by Man et al. (2006c) and Soong et al. (2005) were the only tele-rehabilitation based interventions on executive dysfunction with adults with TBI. Despite a growing number of tele-rehabilitation studies that may now be available, studies that focused on the provision of intervention with adults with TBI over the Internet continue to be limited. A review of the literature on intervention-based tele-rehabilitation studies that were completed specifically with adults with TBI is presented next.

2.3 The Literature Review of Tele-Rehabilitation

2.3.1 Tele-Rehabilitation

Tele-rehabilitation is defined as “the application of telecommunication, remote sensing and operation technologies, and computing technologies to assist with the provision of the delivery of medical rehabilitation services at a distance” (Cooper et al., 2001, p. 1174). This form of service delivery has been reported as a potential solution to bridge the service gaps in
rural communities (Demiris, Shigaki, & Schopp, 2005) and as a cost-saving approach to home-based rehabilitation (Wang, Kreutzer, Bjarnemo, & Davies, 2004). Researchers have explored the use of tele-rehabilitation for different purposes; for example, to provide caregiver training and support (Sander, Clark, Atchison, & Rueda, 2009), home exercise and assessment programs (Durfee, Savard, & Weinstein, 2007; Mountain et al., 2010), clinical consultation (Forducey et al., 2003), and cognitive rehabilitation (Bergquist, Gehl, Lepore, Holzworth, & Beaulieu, 2008). Tele-rehabilitation has also been used to support people that are affected by various conditions including stroke (Brennan, Georgeadis, Baron, & Barker, 2004), TBI (McGrath, Dowds, & Goldstein, 2008), spinal cord injuries (Mathewson, Adkins, & Jones, 2000), Alzheimer’s Disease (Chiu et al., 2009), and individuals with mental health issues (Khasanshina, Wolfe, Emerson, & Stachura, 2008). The use of tele-rehabilitation with individuals with TBI is of particular interest here for the purpose of the current research.

2.3.2 The Literature Search

The questions that this literature review aimed to answer were: (1) what is the current evidence related to tele-rehabilitation-based intervention for adults with TBI; and (2) are adults with TBI receptive to the use of tele-rehabilitation-based intervention. To extract articles that may answer these questions, specific focus was placed on (1) intervention based research, (2) studies related to adults with TBI, and (3) interventions that were provided in a tele-rehabilitation format where a trainer or therapist provided intervention remotely. The following set of keywords was developed for the review: “traumatic brain injury or traumatic brain injuries or brain injury or brain injuries or closed head injury or closed head injuries or head injury or head injuries or head trauma) and (online or internet or Internet or telerehabilitation or tele-rehabilitation or telemedicine or tele-medicine or telehealth or tele-
health or ehealth or e-health or telephone or video conference or video conferencing or teletherapy or tele-therapy) and (intervention or treatment or compensation or therapy or training or remediation or rehabilitation)”. Using these keywords, a search was completed from the earliest available publications at the University of Toronto library electronic system to the time of the search on September 17th, 2010. The following databases were used to cover literatures in the fields of medicine, rehabilitation, allied health, psychology, education, and technology: MEDLINE (earliest from 1950), CINAHL (earliest from 1981), Social Work Abstracts (earliest from 1968), PsycINFO (earliest from 1806), Health and Psychosocial Instrument (earliest from 1985), EMBASE (earliest from 1980), EMBASE Classic (from 1947 to 1979), ERIC (earliest from 1966), and CSA Technology Research Database (earliest from 1962). After narrowing the search to only include studies related to human or humans, age 19 or older, and studies in the English language where possible, a total of 412 articles were found. The articles were screened and duplications were removed manually.

2.3.3 Inclusion and Exclusion Criteria

A set of inclusion and exclusion criteria was developed to guide the selection of the articles for this review. Studies were included if they were intervention studies with clear objective outcomes, completed with adults with TBI, and the intervention was delivered remotely in a tele-rehabilitation format. Studies were excluded if they did not include adults with TBI, they were descriptive studies without clear objective outcomes including description of an intervention or a tele-rehabilitation technology, or if they were non-intervention studies such as reliability studies of assessments delivered in a tele-rehabilitation format. The intervention studies had to have a primary focus on the persons with TBI. Although studies also could involve caregivers, those that mainly focused on caregivers were excluded to
allow a distinctive examination of the application of the tele-rehabilitation-based intervention with individuals living with potential impairments and disabilities post TBI. Studies that examined the use of technology to provide medical treatment or consultation with doctors, one time consultation with clinicians, or the provision of consultation between care providers were not included. The interventions must involve predominantly remote rehabilitation where clinicians were involved at a distance during the intervention process. Therefore, studies that were related to the use of resource or information websites and self-directed intervention tools such as engagement in on-line therapy programs including web-based memory games or self-help programs without clinicians’ inputs were excluded. Finally, this review did not include review papers or tele-rehabilitation interventions that were solely reported in books.

2.3.4 An Overview of the Literature

From the 412 articles found, 19 met the inclusion and exclusion criteria. These articles are summarized in a chart format in Appendix F. Two of the 19 articles were also included in the literature review on the rehabilitation of executive functions for individuals with TBI that was discussed earlier (Man et al., 2006c; Soong et al., 2005). The earliest tele-rehabilitation study that included individuals with TBI was published in year 2000 (Salazar et al., 2000).

2.3.5 An Overview of the Study Designs and Technology Formats

Nine of the 19 studies were randomized control trials (RCT). The number of participants involved ranged from N=1 (McGrath et al., 2008) to N=312 (Bell et al., 2008). Only 4 of the studies included follow-up data (Bombardier et al., 2009; Bourgeois, Lenius, Turkstra, & Camp, 2007; Bradbury et al., 2008; Melton & Bourgeois, 2005).
All of the 19 studies delivered their interventions in the participants’ homes although a face-to-face format was also included as part of the intervention process in 4 of the studies. Telephone was the most frequently used method to deliver tele-rehabilitation (10 of 19 studies: Bell et al., 2004, 2005, 2008; Bombardier et al., 2009; Bourgeois et al., 2007; Bradbury et al., 2008; Melton & Bourgeois, 2005; Salazar et al., 2000; Turkstra & Bourgeois, 2005; Warden et al., 2000). Videoconferencing was combined with the application of custom computer-based training programs in 6 studies (Hermens et al., 2008; Huijgen et al., 2008; Man, Soong, Tam, & Hui-Chan, 2006b; Man et al., 2006c; Soong et al., 2005; Tam et al., 2003), 1 study used videoconferencing in place of regular home visits (McGrath et al., 2008), and 2 studies used a self-developed instant text messaging system to provide memory strategy training (Bergquist et al., 2008, 2009). Eight of the studies used custom designed software and/or hardware to deliver the interventions (Bergquist et al., 2008, 2009; Huijgen et al., 2008; Man et al., 2006b, 2006c; Soong et al., 2005; Tam et al., 2003).

2.3.6 Question One: What is the current evidence related to tele-rehabilitation-based intervention for individuals with TBI?

The 19 studies have various differences including their designs, the intervention approaches examined, and the technologies that were used to deliver the interventions. However, regardless of the format of delivery and the interventions that were used, when the tele-rehabilitation approaches were compared with conventional approaches, most studies found the two approaches to be comparable (Bergquist et al., 2009; Bradbury et al., 2008; Hermens et al., 2008; Huijgen et al., 2008; Man et al., 2006b, 2006c; McGrath et al., 2008; Salazar et al., 2000; Soong et al., 2005; Warden et al., 2000). Greater improvement in individuals who received the tele-rehabilitation interventions was reported in studies that used telephone
interventions to facilitate transition into community living (Bell et al., 2005 & 2008; Bombardier et al., 2009) and when it was used to train spaced retrieval training to learn solutions to everyday problems (Bourgeois et al., 2007) in comparison to receiving usual care (Bell et al, 2005, 2008), no treatment (Bombardier et al., 2009), or an alternate treatment (Bourgeois et al., 2007).

The success of telephone interventions to promote transition into community living was first reported by Bell et al. (2004). In this study, a clinician made telephone contacts with the participants with TBI and / or the significant others within 2 weeks, at 4 weeks, and at 2, 3, 5, 7, and 9 months post discharge from inpatient stay. The telephone intervention was provided in addition to the typical care that the participants would get in the control group. The telephone sessions consisted of a specific format that included the follow-up of previously identified concerns, identification of current issues, and the provision of responses by the coordinator based on the issues raised. Responses may involve education, guidance, reassurance, and to facilitate prioritization and problem solving with the individuals in relations to the concerns that were identified, and they may also involve referrals to community resources, medical assistance, and emergency services. The majority did not require additional referral, as 81% of concerns for significant others and 84% for the participants with TBI were resolved during the phone call sessions. The participants described these 30 to 45 minutes phone calls as helpful.

An RCT study of the scheduled telephone intervention with a 1-year follow-up was reported by Bell et al. (2005). The treatment group who received the telephone calls showed significant improvement in functional status and quality of life at follow-up. When ethnic origin was considered, better outcomes were found in the control group for nonwhites and
individuals with Hispanic background. The authors noted the importance of tailoring treatment approaches for the specific ethnic groups that it aimed to address. They suggested that calls being made to the individuals instead of relying on the individuals to call, providing the intervention within 1 year of onset, and involving the caregivers where necessary may have been important components of the intervention. The data from this RCT study were reanalyzed to examine its impact on depression symptoms (Bombardier et al., 2009). The treatment group was found to have significantly less depression symptoms at 1-year follow-up than the control group.

A similar telephone intervention that focused specifically on individuals with mild TBI was completed using an RCT design (Bell et al., 2008). The time of phone calls were changed to within 2 days of injury and at 2, 4, 8, and 12 weeks post injury. The goal of this intervention also differed in that it focused on the recovery from symptoms associated with mild TBI and on promoting resumption of normal activities. The coordinators used problem clarification and reflective listening techniques to help the individuals to identify and prioritize problems. Modelling problem solving behaviours was also used to illustrate problem prioritization and goal setting. Positive behaviours were reinforced. Similar to the previous RCT completed by Bell et al. (2005), the coordinator would review previously identified problems and their current status and to identify current issues and the participants were also prompted to review their physical, cognitive, emotional, and activity status at each session. Education materials were also sent to the participants and when necessary, referrals were made to community resources and medical providers. Participants who received the telephone calls had significantly fewer symptoms and these symptoms had less impact on daily functioning post intervention. It was concluded that the telephone-based intervention
that focused on symptom management and that encouraged the individuals to resume daily activities was beneficial at minimizing chronic symptoms post mild TBI.

These studies on scheduled telephone intervention for symptom management, functional recovery, and for promoting quality of life for individuals post TBI were promising. The individuals and their caregivers were able to engage in information sharing and problem solve through their issues over the telephone and these added interactions led to better outcomes than found among individuals who did not receive these calls. However, these interventions were provided early post injury and the individuals also may have been receiving conventional interventions prescribed by the physicians. It is unclear rather the positive outcome was a combined effort of the face-to-face intervention with the telephone calls or if the telephone intervention alone was sufficient to promote recovery and function.

One RCT study with military personnel post TBI replaced face-to-face in-hospital intervention with weekly telephone-based community interventions provided by a psychiatric nurse (Salazar et al., 2000). The focuses of the telephone calls were to foster self-direction, facilitate adjustment to having the TBI, and to promote problem solving of everyday issues. Calls were directed to the patients but the caregivers also may have been involved. The nurse received support from a multi-disciplinary team through weekly team meetings. At 1-year follow-up, there was no significant difference found between the groups in return to work or fitness of duty (Salazar et al., 2000; Warden et al., 2000). The military setting, including their distinctive return-to-work processes and support systems, may limit its generalizability to other settings. However, this RCT study demonstrated how tele-rehabilitation received in the community might be comparable to conventional in-hospital face-to-face intervention for individuals with TBI. It is also interesting to note that in all of
these community-based telephone interventions, the coordinator and the nurse both encouraged their participants to problem solve through issues that the participants identified during these calls. These telephone-based interventions applied immediately after acute inpatient stay appeared to be effective with individuals with TBI in promoting function and symptom reduction. However, TBI recovery is a long-term process for many individuals. Many of the studies reviewed earlier for the rehabilitation of executive dysfunctions were completed with individuals that were more than one year post TBI and successes were reported. Thus, it is also important to explore the use of tele-rehabilitation with individuals that have been living with TBI for at least 1 year or more.

Three studies used telephone-based interventions to address memory related issues in everyday activities in individuals that were at least one year post TBI (Bourgeois et al., 2007; Melton & Bourgeois, 2005; Turkstra & Bourgeois, 2005). All 3 studies used errorless learning techniques and spaced retrieval training to promote learning of solutions to everyday problems. In these interventions, goals were first identified with the participants and caregivers during a face-to-face session, which was followed by telephone sessions that involved training the participants to recall established prompt questions and responses for each goal. Prompt questions were asked at a progressively longer durations as the individual began to recall the answer immediately when asked. Improvement in the recall of the appropriate responses was found in all 3 studies. However, one study reported there was a lack of behavioural change in everyday life and the authors suggested having consistent caregivers and using action-focused goals could be beneficial (Turkstra & Bourgeois, 2005). Another study reported maintenance at follow-up and that transfer of learning onto untrained but related activities occurred post intervention (Melton & Bourgeois, 2005). The third study
found that the spaced retrieval training provided over the telephone resulted in significantly better goal achievement and maintenance than telephone-based didactic strategy instruction (Bourgeois et al., 2007). However, both interventions in this third study resulted in fewer memory problems and there were reports of transfer of the strategy to untrained behaviours. Neither group had significant change on the community integration measures.

Further evidence to support telephone-based interventions may be drawn from a study that compared education only with cognitive behaviour therapy in either individual telephone or group face-to-face formats (Bradbury et al., 2008). In this matched control study, adults that were at least one year post injury were recruited. Significant reductions in stress and improved emotional disturbance were found after 10 sessions of cognitive behaviour therapy when provided in either face-to-face or telephone format but there were no significant change in community integration. Education alone did not result in significant improvement. The successful implementation of the cognitive behaviour therapy in a telephone-based format showed promise in the ability to transform current therapy approaches into a tele-rehabilitation format to reach individuals with TBI that may not be able to access the specialized therapy program face-to-face.

Although telephone-based rehabilitation has led to promising outcomes, the added benefit of the use of gestures and expressions to aid communication during video-conferencing was reported in one study and is worth further exploration. Video-conferencing was used in an ABA design single case study that compared conventional weekly home visits with videoconferencing (McGrath et al., 2008). The participant received support from a mentor and a clinical supervisor to guide him to transition into community living from a year stay at a skilled nursing facility. Four weeks of weekly home visits and phone calls with the
supervising clinical coordinator were replaced by 4 weeks of videoconferences and phone calls before concluding with 4 weeks of home visits and telephone calls again. A mentor, who was trained to supervise the implementation of home integration activities, was with the participant in his home during the videoconferences with the clinical supervisor. The feedback received from the clinicians in this case study was mostly positive. Transmission delays and quality during the videoconferences were identified as issues, however the clinicians noted that videoconferences were easier to schedule and travel costs were saved. The satisfaction ratings of in-person interactions and videoconferencing including effectiveness of communication were comparable for both the participant and the clinical coordinator. However, the participant reported that he was self-conscious with having a computer and camera in his living space and found his inability to show the clinical coordinator things around the home to be limiting. He did not find videoconferencing to be superior to in-person home visits. The presence of the mentor in the home during the videoconferences may resemble caregivers’ support. The presence of face-to-face interventions prior, the presence of a mentor on-site, and knowing there will be face-to-face interventions after the videoconference sessions might have influenced the participant’s experience and its subsequent outcome. The client’s feedback on its limitations regarding the discomfort of having a camera or computer in his living space and the inability to show the clinical coordinator around the home are important to consider for future studies. However, the authors found the study outcome suggested the potential to substitute at least some of the home visits with videoconferences effectively. Future studies with a larger sample size on the use of videoconferences to address community integration and how some of the identified challenges may be overcome will be beneficial.
The technology that was used in McGrath, Dowds, and Goldstein’s study (2008) and the telephone intervention studies previously discussed all involved commercially available hardware and Internet or telephone connections for home and office use. The remaining 8 studies from the 19 tele-rehabilitation studies used custom design software and/or hardware to target physical or cognitive training.

Two studies used a newly developed instant messaging system that was designed to be easy to use and that has security features including password protection (Bergquist et al., 2008, 2009). One of these was a pilot feasibility study with 10 participants that used the instant messaging program to teach participants to use the calendar to address everyday memory issues (Bergquist et al., 2008). The drop out rate was found to be low (4%) and only 2 of the 8 participants involved missed any appointments during the first 10 sessions. The study showed that individuals with TBI could learn to independently log in and use the instant messaging system.

The effectiveness of the instant messaging system was examined and reported in another study by Bergquist et al. (2009). In this study, 30 sessions of calendar training was compared with 30 sessions of control diary training where the participants were asked to keep a log of their daily activities. Three specific training phases were used in the calendar training to guide (1) acquisition, (2) application, and (3) adaptation. Special focus was placed on promoting the use of a calendar in everyday activities. Increased compensatory strategy use and improved family ratings in memory and depression scales were reported after both forms of training. There were no significant differences in outcomes between the two interventions and no significant changes were noted in community integration. In regards to its completion rate and technology use, 30% of the participants (6/20) did not
finish all or part of the program and that 20 of the 21 participants recruited were able to log in and use the instant messaging system independently. Although a no-treatment group was not available and both treatment groups had similar outcomes, the positive changes that were achieved showed promise for the use of a text messaging system to deliver interventions.

Memory issues also were the targets in another tele-rehabilitation study that used custom designed programs (Tam et al., 2003). In this study, customized training and assessment software were used for each of 3 cases to train word recognition, prospective memory, and visual imagery to help memorize at least 10 items. The ABA study design consisted of “A,” representing the no intervention phase, and “B,” the intervention phase. The therapist at the facility shared control of the computer screen of the participants who were at home and videoconferences were used for the therapists to provide cues as needed. Improvement in the targeted recall areas was found during training but a return to baseline performance was observed when the intervention was removed. Although further examination of the intervention, study design, and the evaluation process may be beneficial to explore how these may have affected outcomes, the participants’ feedbacks were mostly positive. There were reports of transfer of learning into everyday tasks and increased self-confidence post training. All 3 participants found tele-rehabilitation to be an acceptable format to receive therapy and the improved performance during training may also show the receptiveness of this interface by the participants.

Several studies compared face-to-face treatment with tele-rehabilitation approaches including those that used a specially designed analogy-based problem solving program (Man et al., 2006b, 2006c; Soong et al., 2005) and those that used a home-based tele-rehabilitation system for arm or hand function (Hermens et al., 2008; Huijgen et al., 2008). In the
computer-based upper extremity training programs, the treatment group was compared to a control group who received usual care. The authors concluded that the upper extremity training program delivered remotely was at least as effective and as feasible as usual face-to-face care (Hermens et al., 2008; Huijgen et al., 2008). In the analogy-based problem solving training studies, the same program content was used in 3 treatment groups: self-directed computer-assist group, on-line computer-assisted group, and therapist-assisted group (Man et al., 2006b, 2006c; Soong et al., 2005). All 3 studies found tele-rehabilitation and face-to-face formats to be comparable to deliver the training program. As discussed in the previous review reported in this chapter, self-efficacy improved in similar ways in all 3 groups in the pilot study (Soong et al., 2005), but greater self-efficacy was reported in the face-to-face, therapist-led, groups in the later studies (Man et al., 2006b, 2006c). One question that may be raised is that although videoconferencing was possible during the on-line computer-assisted sessions, it was unclear to what extent that the therapist was involved (Man et al., 2006c). Whether the level of self-efficacy would be altered if the focus was less on the computer program and more on the trainer who interacted with the participant through a videoconferencing format has yet to be determined. However, it may be difficult to replicate these studies that required specialized programs and tools for further examination and it may also be challenging to translate these into clinical practice potentially due to financial and technical support constraint.

2.3.6.1 Question One Summary

The first intervention-based study on tele-rehabilitation with adults with TBI was only published in 2000. However, 19 studies have already been published in the past 10 years and almost half were RCT studies. Most of the evidence points to the use of telephone-based
interventions and most studies found this to be a feasible modality that was comparable to face-to-face treatments, and superior to no intervention. The evidence on the use of videoconferencing is limited. Videoconferencing was used as part of computer-administered training programs thus creating barriers to examine its challenges and benefits as a stand-alone tool to provide interventions remotely. The study by McGrath et al. (2008) provided some insight into the potential challenges that may be faced and also into the promising potential for videoconferencing to be used to substitute face-to-face home visits. There are yet many questions to be answered.

Although remote service delivery was the primary design of all 19 studies, face-to-face assessment was used in all but one study, in which Bell et al. (2004) used telephone call frequency and content as their outcome measures. There is no evidence on the feasibility of or the effectiveness of using tele-rehabilitation from the start to finish without any direct face-to-face interaction between the provider and the individuals with TBI. Does tele-rehabilitation intervention require some level of face-to-face components to be effective? How can change and improvement be reliably measured? Does TBI severity or functional status affect one’s ability to learn and use tele-rehabilitation? Will feasibility and effectiveness change depending on the presence of a caregiver or a mentor during an intervention? What types of interventions and what are the components of the interventions that may or may not be feasibly or effectively applied in a tele-rehabilitation format and which tele-rehabilitation formats may be more effective or feasible in what situations? If a tele-rehabilitation approach is found to be feasible and effective, how may it be transferred to apply in the real-world health and community care settings? The list of questions is endless as this area of research is still young and growing. Building evidence to examine the use of
the various potential tele-rehabilitation modalities with the current or new intervention approaches to better enhance the everyday functions of individuals with TBI definitely need to be further explored. The current study aims to provide preliminary data through a series of case studies to examine the use of videoconferencing as a tele-rehabilitation medium to deliver a problem solving based approach called the Cognitive Orientation to daily Occupational Performance (CO-OP) with the use of fully commercially available hardware and software. Based on this review, this is the first study to examine the use of a tele-rehabilitation format to deliver the CO-OP approach with adults with TBI.

Given the limited research in the area of tele-rehabilitation and TBI, it may be worthwhile to also look at existing evidence available in the use of tele-rehabilitation with other populations. Kairy, Lehoux, Vincent, and Visintin (2009) completed a systematic review of tele-rehabilitation articles published until February 2007. Their review aimed to evaluate the clinical outcomes and processes as well as costs that are associated with the provision of tele-rehabilitation for direct clinical services. They found and analyzed 28 related articles including 8 RCT studies, 7 quasi-experimental trials with control groups, 9 quasi-experimental pre-post trials without control groups, and 4 studies with post intervention assessment-only. Their search was not limited to any particular diagnostic group. The search resulted in studies that targeted a wide spectrum of issues including daily functioning, return to work, range of motion, gait, pain, cognition, speech, skin integrity, falls, quality of life, fatigue, and depression. The formats in which the interventions were delivered also varied. Some incorporated interpersonal interactions and some had none. Some focused on receiving exercise programs that piloted the development and the use of different biomechanical innovations, while others focused on education and consultation
using less complicated technologies comparably. Improvement was reported following tele-
rehabilitation intervention in all of the studies found in their systematic review. Similar to
the outcomes of some of the tele-rehabilitation studies found in this review, Kairy et al.
(2009) suggested that tele-rehabilitation might be comparable to face-to-face interventions.
The use of tele-rehabilitation to deliver specific interventions is worth further exploration.

2.3.7 Question Two: Are adults with TBI receptive to the use of tele-rehabilitation-
based intervention?

Although the treatment outcomes maybe comparable between face-to-face and tele-
rehabilitation formats, whether individuals with TBI want to or are receptive to receiving
therapy remotely will likely affect compliance and how this delivery method will translate
into actual clinical use. Feedback from the participants on their satisfaction with and
perception of the tele-rehabilitation process was only reported in 4 of the 19 studies reviewed
(Hermens et al., 2008; Huijgen et al., 2008; McGrath et al., 2008; Tam et al., 2003).
However, the available input provides a preliminary view of how individuals with TBI may
respond to receiving tele-rehabilitation interventions. Users’ satisfaction was measured in
both Hermens et al. (2008) and Huijgen et al. (2008) studies with the majority of the users
finding the tele-rehabilitation programs satisfactory. In one study, participants reported they
had increased self-confidence and they found the tele-cognitive programs to have met their
needs (Tam et al., 2003). Internet connection quality was suggested as needing improvement
in 2 studies (McGrath et al., 2008; Tam et al., 2003). Other areas that posted challenges for
the participants were discomfort with having the tele-rehabilitation equipment at home and
their limited ability to show clinicians around the home when using videoconferences to
replace in-person home visits (McGrath et al., 2008).
Dropout rate may also provide some insight on program adherence when applied in a tele-rehabilitation format. Dropout or incompletion rates were about 30% in Bergquist et al. (2009) and 6% in Man et al. (2006c). Completion and dropout information were available in the study by Man et al. (2006c). Everyone in the therapist-assisted group completed the program, while 4 did not finish the on-line program and 2 did not finish the program in the computer-assisted group. From this one study, although the overall dropout rate was only 6%, it appears that it was harder to retain participants in the on-line program than in the others. However, one face-to-face study on the rehabilitation of executive functions reviewed earlier in this chapter had a dropout rate of about 20% (Rath et al., 2003). Whether individuals with TBI are less receptive to on-line tele-rehabilitation and if their receptiveness interfered with program adherence is still unclear and will need further investigation. It may be beneficial for future tele-rehabilitation studies to include a qualitative component to capture participants’ experiences and feedback in the use of the tele-rehabilitation in addition to capturing the effectiveness of the intervention programs.

Given the limited information that is available from individuals with TBI who have received tele-rehabilitation, it may be useful to turn to other studies that have examined the general perception of individuals with TBI on receiving tele-rehabilitation. Ricker et al. (2002) developed a survey with the help of a focus group that consisted of brain injury survivors to determine if individuals with acquired brain injuries would be favourable to accessing computer-based tele-rehabilitation. The survey was sent to 400 individuals through the Brain Injury Association of New Jersey in the United States and 71 (18%) returned their surveys. The person with the brain injury completed the surveys in 58% of the cases. From the total respondents, 63% had a TBI with a median of 9.8 years post-injury.
The cognitive impairments that they rated as “moderate” to “a lot” of problems were memory (65%), attention (54%), following directions about getting from one place to the next (54%), following instructions for a task (52%), switching from task to task (51%), following conversations (45%), and controlling emotions (42%). All respondents reported they experienced some level of symptoms. These numbers further emphasize the long-term cognitive and emotional deficits that one may experience after sustaining a brain injury. The significant cognitive issues that were reported in the survey were also reflected in studies that examined the long-term disabilities of individuals living with brain injuries (Dikmen, Machamer, Powell, & Temkin, 2003; Lannoo, Brusselmans, Eynde, Laere, & Stevens, 2004).

With respect to computer usage, 87% of the survey respondents reported they have used a computer or laptop, 59% were using one at the time of the study, 5% reported using a hand-held computing device, 55% has used emails, and 54.2% has used the World Wide Web. Among the computer users (n=42), 86% could access the Internet from home and the next most frequently reported venue was the workplace. Forty percent of the computer users identified computer and Internet cost as the primary barrier in using the Internet. Memory limitations and difficulty following instructions were also identified as barriers by 33% of the computer users. Only 3 respondents reported physical barriers as limiting factors to computer use (Ricker et al., 2002). Thus, just over half of the individuals surveyed might have the basic equipment needed and most of the computer users already had Internet at home to allow them to access some form of Internet-based tele-rehabilitation if such services were available.

Most (73%) of the computer users indicated they would be comfortable with accessing the Internet for “health-related reasons” if secured connections and storage were
ensured. Among the computer users, 53% reported they would likely or very likely use Internet-based services to access TBI-specific medical information, community resources, or exercises to improve memory function. From the same group, 55% reported they would likely or very likely exchange written information such as medication instructions with their doctors through the Internet. From all respondents (N=71), a majority (71%) reported they would likely or very likely use an Internet-based service that would provide TBI-specific assistance with or training on activities of daily living.

Cognitive-based interventions received the most interest from the respondents. The majority of the respondents expressed interest in using Internet-based exercise programs to improve memory (80%), attention (70%), and problem solving (72%). Most of the respondents (75%) also reported they would pay for such Internet-based services (Ricker et al., 2002). Although data from this 2002 study may be slightly older and not readily apply beyond New Jersey in 2002, it does provide some insights into the needs and readiness of the use of Internet-based tele-rehabilitation post brain injuries. These findings suggested that cognitive symptoms continued to be experienced years after TBIs are sustained and they also direct our attention to the use of Internet-based intervention to address cognitive symptoms and activities of daily living, and that majority of the individuals surveyed reported they were ready for this format of service delivery medium.

Another survey was completed in Philadelphia in the United States, to examine Internet and computer access, problems, desires, and skills of individuals with TBI (Vaccaro, Hart, Whyte, & Buchhofer, 2007). Eighty participants with moderate to severe TBI and an average age of 39.1 years were recruited from outpatient and community programs to complete the survey. Two thirds of the participants had a computer but only half of the
participants had Internet access. Younger participants and individuals with higher education background were more likely to use the Internet. Non-white (mostly African-American) participants had less Internet access. There was no significant correlation between Internet use and income and no significant difference was found between users and non-users in their perceived level of cognitive difficulty. Lack of knowledge and lack of access were the top two reasons for not accessing Internet in this group of participants. The top three areas that individuals with TBI were using the Internet for were email, surf the web for fun, and to find leisure activities. The learning patterns changed between individuals who learned to use the Internet prior to their injury and those who learned to use it post injury. Most individuals, 63%, who had used the Internet pre-TBI learned it by using it and 17% learned it in class. Of individuals who learned to use the Internet after their injury, 59% learned from friends or family, 43% learned by using it, and one learned from his or her therapist. This study echoed findings from the previous review reported by Ricker et al. (2002) in which about 50% of the individuals surveyed had access to Internet in their homes. Although Ricker et al. (2002) found that cognitive impairments and technology-related cost have limited access to Internet, a survey by Vaccaro et al. (2007) found that income and cognitive issues did not differentiate Internet users with non-users. The variations in the survey findings may be related to various factors including the differences in the population characteristics in the two cities and the types of questions asked, the 2002 survey went more in-depth in seeking information on the individual’s cognitive issues, which could have triggered response variations among them.

2.3.7.1 Question Two Summary

The ability to generalize the findings from the two surveys (Ricker et al., 2002; Vaccaro et al., 2007) onto the culturally and geographically diverse Canadian population may be limited.
Cost, cognitive impairments, computer and Internet knowledge and access, availability of technology support, participants’ comfort, and the intervention requirements may create challenges in delivering and accessing Internet-based services. It is promising to see that in the two surveys, about half of the individuals with TBI may have Internet access and may have personal computers in their homes, and that many of them may be interested in partaking in Internet-based therapy. Also, Hermens et al. (2008) and Huijgen et al. (2008) found high participants’ satisfaction with the tele-rehabilitation programs in their studies.

The availability of research and the presence of evidence in the use of tele-rehabilitation with individuals with TBI and on the receptiveness of Canadians to this format of service delivery are truly limited. From the 19 tele-rehabilitation intervention studies found in this literature review, only one was completed in Canada (Bradbury et al., 2008). Given the geographic make-up of Canada where access to specialized rehabilitation services for individuals with TBI is often limited especially in the rural communities, future studies in the use of tele-rehabilitation in the Canadian context for individuals with TBI may be beneficial.

2.4 Conclusion

The literature review on tele-rehabilitation provides promising evidence that tele-rehabilitation may be comparable to face-to-face intervention. The potential for tele-rehabilitation is also reflected in a report from the Commissioner on the Future of Health Care in Canada, which suggested funding and plans to expand technology use for health access in the rural and remote Canadian communities (Romanow, 2002). Plans to expand broadband availability in rural Ontario were also reported (Government of Ontario, 2010a,
2010b, 2010c). Increasing access to the Internet may offer increased potentials to build a more accessible health care and rehabilitation service network in Canada.

However, the evidence behind the use of tele-rehabilitation within the Canadian context needs to be expanded. There is extremely limited research that addresses executive dysfunction with individuals with TBI using a tele-rehabilitation format. There is a growing evidence to support the use of meta-cognitive training to address executive dysfunction post TBI; however, none of the tele-rehabilitation studies have examined how a meta-cognitive training approach may be applied in a remote format.

In this thesis, a series of case studies was conducted to explore the use of videoconference to deliver a meta-cognitive approach that has shown promise with individuals with TBI - the Cognitive Orientation to daily Occupational Performance (CO-OP) approach. This research aims to provide preliminary data to contribute to the study of tele-rehabilitation and how it may be used to address executive dysfunction and to promote community integration with individuals living with TBI in Canada.
CHAPTER 3 – MANUSCRIPT
(Prepared for submission to Neuropsychological Rehabilitation)

Using tele-rehabilitation to address executive dysfunction and to promote community integration after traumatic brain injury: A pilot study

ABSTRACT

Executive dysfunction is known to affect community integration in adults with traumatic brain injury (TBI). Recent evidence supports meta-cognitive training for the rehabilitation of executive dysfunction. The Cognitive Orientation to daily Occupational Performance (CO-OP) approach is a meta-cognitive intervention that has shown promise when used with adults with TBI. However, access to this training is often limited, particularly in rural communities. The objectives of the study were to investigate the feasibility of implementing the CO-OP approach in a tele-rehabilitation format and to examine its impact on community integration and executive dysfunction for adults with TBI. A series of 3 case studies with 3-months follow-up was conducted. CO-OP was used to train 3 of 5 participant-identified goals. Two goals were not trained to allow examination of transfer. Outcome measures included the Canadian Occupational Performance Measure, the Mayo-Portland Adaptability Inventory-4 Participation Index, and the Dysexecutive Questionnaire. Descriptive analysis was used. The CO-OP approach delivered in a tele-rehabilitation format was found to be feasible and all participants showed improvement in both trained and untrained goals. Trends toward fewer symptoms of executive dysfunction and greater community integration were demonstrated. All
participants expressed satisfaction with the Internet delivery method. Further research is warranted.

Keywords: brain injury, executive function, tele-rehabilitation, community integration

**INTRODUCTION**

There is an increasing amount of evidence to support the rehabilitation of executive function post TBI. Two systematic reviews completed by Cicerone et al. (2000, 2005) recommended the practice guideline of implementing formal training of problem solving strategies in application to everyday situations and functional activities to address executive dysfunction and problem solving ability of individuals with traumatic brain injury (TBI). They also recommended the use of self-instruction and self-monitoring to promote internalization of self-regulation strategies as a practice option to remediate executive dysfunction (Cicerone et al., 2005). Another systematic review completed by Kennedy et al. (2008) concluded that there was compelling evidence to support the use of step-by-step meta-cognitive training to improve executive dysfunction in personally relevant situations.

One meta-cognitive approach that adheres to the recommendations made by Cicerone et al. (2000, 2005) and Kennedy et al. (2008) is the Cognitive Orientation to daily Occupational Performance (CO-OP) approach (Polatajko & Mandich, 2004). This meta-cognitive approach provides a structure of step-by-step problem solving strategy training to explicitly address the individuals’ self-identified goals. Checking one’s performance to promote self-monitoring is an integral part of the CO-OP approach as is the explicit training of generalization and transfer of the strategies (Polatajko & Mandich, 2004). When applied in a face-to-face format with adults with TBI, the CO-OP approach demonstrated the ability
to improve functional performance, maintenance, and transfer of outcomes (Dawson et al., 2009).

Given the promise that the CO-OP and other meta-cognitive training approaches show, it is particularly concerning that access to health and rehabilitation services is often limited especially in rural communities (Keightley et al, 2009; Laurent, 2002). Inequitable distributions of health care clinicians between urban and rural areas and long commute to services have been recognized as two of the barriers to service access (Laurent, 2002; World Health Organization, 2009). To bridge this gap, the use of information technologies to link patients and health care providers has been recommended (Romanow, 2002).

The use of information technologies, or telecommunication, to provide rehabilitation services at a distance is referred to as tele-rehabilitation. Tele-rehabilitation has been found to be comparable to face-to-face interventions in a systematic review completed by Kairy, Lehoux, Vincent, and Visintin (2009). In the twenty-eight articles that were included in their review, only 2 were related to individuals with TBI. One was a case study on three individuals that received training on memory and word-finding abilities through customized computer programs (Tam et al., 2003). The other study was a randomized control trial (RCT) that examined the use of an analogy problem solving program through different modalities including face-to-face, online computer-assisted, computer-assisted, and a control group who did not receive treatment (Man, Soong, Tam, & Hui-Chan, 2006c). Both studies reported improvement in the respected trained areas post interventions and Man et al. (2006c) found outcomes to be comparable between all modes of delivery of the problem solving program.
The number of intervention studies related to the use of tele-rehabilitation and individuals with TBI has grown since the systematic review completed by Kairy et al. (2009). These studies included the use of an Internet-based upper extremity exercise program (Hermens et al., 2008; Huijgen et al., 2008), a telephone-based memory and everyday function program (Bourgeois, Lenius, Turkstra, & Camp, 2007), and an Internet-based compensatory strategy training provided through text-messaging (Bergquist et al., 2009; Bergquist, Gehl, Lepore, Holzworth, & Beaulieu, 2008). Other studies that have also provided telephone-based counselling to promote symptom management (Bell et al., 2008), clinical supervision during transition to community living (McGrath, Dowds, & Goldstein, 2008), cognitive behavioural therapy to address emotional distress post injury (Bradbury et al., 2008), and problem solving strategies training for depression management (Bombardier et al., 2009). However, none of the intervention studies found in our literature search were related to the use of tele-rehabilitation-based meta-cognitive training to specifically address executive dysfunctions post TBI.

To our knowledge, this pilot was the first study to investigate whether a meta-cognitive approach, the CO-OP approach, can be used effectively in a tele-rehabilitation format to promote community integration and to address executive dysfunction with adults post TBI. We chose to implement the CO-OP approach in a tele-rehabilitation format, not only because of the promising outcomes that it has shown in its face-to-face format, but also because we had observed in our previous work that some of the CO-OP intervention sessions involved mostly verbal exchange between the therapist and the participant (Dawson et al., 2009; Dawson, Hunt, Lemsky, & Polatajko, 2010). The potential to rely on verbal dialogue
during training was seen as an opportunity to deliver the CO-OP training remotely through an Internet-based videoconferencing format.

The specific objectives and sub-objectives of this pilot study were to:

1. Explore the feasibility of administering the CO-OP approach via a tele-rehabilitation format based on:
   a) Adherence to the seven key features of the CO-OP approach,
   b) Technology delivery process,
   c) Participants and significant others’ receptiveness to the tele-rehabilitation format and the approach.

2. Examine if the CO-OP approach in its tele-rehabilitation format can promote community integration and help manage executive dysfunction in adults with TBI.

**METHODS**

**Design**

A pilot series of 3 case studies with baseline, post-intervention, and 3-months follow-up measures was conducted.

**Participants**

Participants (n=3) and their significant others were recruited in Canada through advertisements on regional and national brain injury association websites and newsletters and through word-of-mouth. Individuals were eligible for inclusion if they were 18 years old or greater, had sustained a TBI at least one year ago, had no other neurological or psychiatric disease that required hospitalization, no concurrent depression or substance abuse, and had evidence of executive dysfunction based on neuropsychological testing. As well, participants
had to be able to identify specific day-to-day difficulties that they had and had to have access to a computer with a high-speed Internet connection.

Participants were asked to identify a significant other (SO) who knew them well and could participate in the study. The SOs had to be 18 years old or greater and express a willingness to participate in the training process. As well, participants and their SOs had to have adequate language ability to understand and be understood in English in both written and verbal format and be willing to participate in the proposed intervention training and the assessment process. All were made aware of the intervention process and the technology requirement prior to providing their consent. All provided written, informed consent. This study obtained ethics approval from the Research Ethics Boards at the University of Toronto and at the Baycrest Centre.

The Intervention

The CO-OP approach is “a client-centred, performance-based, problem solving approach that enables skill acquisition through a process of strategy use and guided discovery” (Polatajko & Mandich, 2004, p. 2). Polatajko and her colleagues originally developed the CO-OP approach to help children with Developmental Coordination Disorders to acquire motor-based skills (Polatajko & Mandich, 2004). The approach has since been used with promising outcomes with children with Asperger’s Syndrome (Rodger & Brandenburg, 2009), adults with stroke (McEwen, Polatajko, Huijbregts, & Ryan, 2009, 2010; Skidmore et al., 2011), and adults with TBI (Dawson et al., 2009, 2010) in a face-to-face format.

The CO-OP approach was based on Meichenbaum’s Self Instructional Training (SIT) program in which he focused on teaching thinking patterns or cognitive strategies to support desired skills (Meichenbaum, 1977; Polatajko & Mandich, 2004). Through dialogues, the
SIT program directs the individual to discuss the task’s purpose (goal), identify strategies to employ (plan), to execute these strategies (do), and to evaluate its outcome (check) (Meichenbaum, 1977). This global strategy, Goal-Plan-Do-Check, is utilized in the CO-OP approach to guide the participants to achieve their goals. Development of domain specific strategies is also emphasized in the CO-OP approach to guide the participants to discover and apply in task-specific situations that are relevant to their goals (Polatajko & Mandich, 2004).

Clients are viewed as collaborators in the CO-OP approach; they are involved in the identification of the goals and in the development, implementation, and monitoring of their plans. This is also reflected in a key feature of the approach, “guided discovery,” where therapists coach the clients to generate plans rather than telling them what to do.

The CO-OP approach has four objectives: skill acquisition, strategy use, generalization of learning, and transfer of learning. In the CO-OP protocol, generalization of learning is defined as the ability to apply one’s newly learned skills in real life situations without the help of the therapist. Transfer of learning is defined as the ability to adapt and transfer the learned skills or strategies to meet the demands of new skills that one may encounter in everyday life (Polatajko & Mandich, 2004).

To achieve these objectives, seven key features are reinforced to promote its effectiveness and which define the CO-OP approach. They are: client-chosen goals, cognitive strategy use, guided discovery, parent / significant other involvement, intervention format, dynamic performance analysis, and enabling principles.

The original CO-OP protocol involved 10 1-hour sessions that were provided twice weekly for 5 weeks (Polatajko & Mandich, 2004). The protocol was modified for adults with TBI and involved 20 1-hour sessions provided twice weekly for 10 weeks (Dawson et al.,
2009). The CO-OP intervention format is structured to include a preparation phase for goal setting, an acquisition phase for skill acquisition and strategy learning, and a verification phase to reinforce learning and to promote generalization. Homework is also used throughout to promote generalization and transfer (Polatajko & Mandich, 2004). Dawson et al. (2009) added specific generalization and transfer training through practice of strategy application, beyond the goals developed, at each session. For this study, the intervention protocol used by Dawson et al. (2009) was adapted for implementation over the Internet. A binder containing blank goal forms and a printed page containing the global strategy, goal-plan-do-check, was provided to the participants. The first author (EN), a licensed occupational therapist administered the intervention with training and supervision by Drs. Dawson and Polatajko and Ms. Hunt. Training involved attending a 2-day CO-OP workshop, individual training sessions prior to and during the intervention phase, and joint-intervention sessions. Meetings were held to review video-recordings and to exchange feedback to ensure the protocol was followed.

**Technology**

The intervention sessions were completed through videoconferencing using Skype™, a software program that allows voice and video calls over the Internet. This program uses an encryption process to promote security for users (Berson, 2005). The assessments were completed via videoconferences with the participants and via telephone with the SOs. Sessions were recorded using Pamela for Skype™ Professional Version and stored in a secured database. The recording software, Pamela for Skype™ Professional Version, was selected due to its ability to save both the telephone and videoconference calls locally in the secured database without saving the content online. Logitech® Webcams C200 and
Logitech® ClearChat Noise-Cancelling Headsets were provided to all participants and were also used by the therapist and assessors. The programs and equipment selected were relatively inexpensive to promote future translation into clinical practice.

Participants were provided with printed information including a web-link to the Skype™ website and their security page for information on privacy and set-up of the program. Although more than one technology training session was offered to the participants, participants received only one training session prior to the assessment process. Training was provided over the telephone and through videoconference.

**Measurements**

Only tests that could be administered orally without specialized programs over the Internet or via telephone were considered for use in this study. Except for objective 2’s primary outcome measure that was initially completed by the therapist, trained research assistants, who had no involvement in the provision of the intervention, completed all pre- and post-intervention measures.

**Neuropsychological Assessments**

Neuropsychological tests were completed once at pre-intervention to capture participants’ cognitive characteristics. The tests were selected to reflect typical cognitive difficulties reported by individuals with TBI and to identify whether executive dysfunction was present. They included, for mental flexibility and executive function: the Oral Trail Making Test-B (Mrazik, Millis, & Drane, 2010) and the FAS Verbal Fluency (Borkowski, Benton, & Spreen, 1967); for learning and memory: the Hopkins Verbal Learning Test-Revised (Benedict & Brandt, 2007; Brandt, 1991); for attention: the Digit Span subtest from the
Wechsler Adult Intelligence Scale – Third Edition (WAIS-III) (Tulsky, Zhu, & Ledbetter, 1997); and as a proxy for pre-morbid intelligence: the Vocabulary subtest from the WAIS-III (Tulsky et al., 1997).

With the exception of the Oral TMT, all of these tests have been widely used with individuals with TBI and have sound psychometrics (Strauss, Sherman, & Spreen, 2006). Normative data is available on the Oral Trail Making Test (OTMT) and the OTMT-B was found to correlate with the Written Trail Making Test (WTMT) (Marzik, Millis, & Drane, 2010). The WTMT has shown good psychometrics and has been widely used with the TBI population (Strauss, Sherman, & Spreen, 2006). The OTMT-B was included in the current study because it can be administered orally over the Internet and that it is in the public domain, thus readily accessible as a potential tool for remote administration by clinicians.

Outcome Measurements

**Outcome Measures for Objective 1: To explore the feasibility of administering the CO-OP approach via a tele-rehabilitation format.**

Feedback interviews, the therapist’ field notes, and session recordings were used. Feedback interviews were completed with the participants and the SOs at post-intervention by the therapist. The interviews were semi-structured to obtain participants’ and their SOs’ perception of the approach and the use of the tele-communication medium to participate in the study. The therapist’s field notes were collected throughout the study on the intervention, the administration, and the technology delivery processes. Session recordings were used during the supervision process and to determine treatment adherence.
Outcome Measures for Objective 2: To examine if the CO-OP approach in its tele-rehabilitation format can promote community integration and help manage executive dysfunction in adults with TBI.

Objective 2 Primary Outcome Measure

(1) The Canadian Occupational Performance Measure (COPM) is a standardized test that is completed in a semi-structured interview format (Law et al., 1998). It was used to guide participants to identify their current performance and problem areas. Participants rated the importance of each problem area with a 10-point scale and selected the areas that they would like to address. Following this, they were guided to transform these areas into goals for this study. The participants and their SOs provided their perceptions of the participants’ performance and satisfaction ratings for the goals at each assessment phase. A 10-point scale, where 1 implies the least and 10 implies the most, was used for both the performance and the satisfaction ratings. The therapist administered the COPM at pre-intervention to guide the participants to develop 5 goals, and again at post-intervention to develop 3 goals. Only 3 of the 5 goals set at pre-intervention were specifically addressed by the therapist using the CO-OP approach. Untrained goals developed at pre- and post-intervention were used to allow examination of transfer of the approach. The goals set at post-intervention aimed to examine the transfer of the approach on new goals developed beyond the training period. The therapist obtained the initial performance and satisfaction ratings from the participants and their SOs on the goals developed at each of the pre- and post-intervention phase. Trained research assistants obtained the participants and the SOs’ ratings on both trained and untrained goals in the subsequent assessment periods at post-intervention and at 3-months follow-up.
Objective 2 Secondary Outcome Measures

Due to the potential intra-individual variability in performance that one may experience post TBI (Bleiberg, Garmoe, Halpern, Reeves, & Nadler, 1997; Burton, Hultsch, Strauss, & Hunter, 2002; Stuss, Murphy, Binns, & Alexander, 2003), the secondary measures were administered three times over 3 weeks at each assessment phase.

(1) The Dysexecutive Questionnaire (DEX), a 20-item questionnaire, was used to capture participants’ and SOs’ perception of the impact of executive dysfunction in the participants’ everyday life. Higher DEX scores are associated with poorer performance in the Behavioural Assessment of the Dysexecutive Syndrome (BADS) for individuals with brain injury. The BADS measures a person’s executive functions including planning, organizing, initiating, and monitoring (Wilson, Alderman, Burgess, Emslie, & Evans, 1996).

(2) The Mayo-Portland Adaptability Inventory, Participation Index (MPAI-4-P) is an 8-item questionnaire that uses a 4-point scale to measure the participants’ level of independence in various daily activities including self-care, leisure, homemaking, transportation, financial management, and employment. It was designed to target individuals with acquired brain injuries (Malec, 2005). This questionnaire was completed by the participants and their SOs.

(3) The Flanagan’s Quality of Life Scale (QOL) is a 2-part questionnaire that was completed by the participants only. Each part consists of 15 questions or areas, such as personal comforts, relationships, recreation, work and learning, and life purpose (Flanagan, 1982). Part 1 measures the importance of each area and part 2 measures how well each area is met. Quality of life is conceptualized as how well important needs are met. A score for QOL is determined by summing the following formula \( X_i(Z_i - Y_i) \) where \( X \) is the importance rating (on a scale of 1 to 5); \( i \) is the QOL area; \( Z \) is the maximum possible needs met rating (\( Z_i = 5 \) in
this study); and Y is the needs met rating given by the participant (on a scale of 1-5) (Brown & Vandergoot, 1998).

(4) The Life Space Questionnaire (LSQ) was also completed 3 times at each assessment phase to capture a person’s mobility from within the home to the broader community through 9 questions. The original LSQ asked the subjects to recall their distance travelled in the past 3 days. This was changed to past 7 days for this study to provide a wider time frame for consideration. Good test-retest reliability, construct and criterion validity was found with community dwelling older adults (Stalvey, Owsley, Sloane, & Bell, 1999). The LSQ was completed by the participants and their SOs.

**Planned Analysis**

To address objective one, the feasibility of implementing the CO-OP approach in a tele-rehabilitation format, descriptive analyses were used. Specifically, data from the feedback interviews, therapist’s field notes, and session recordings were used to describe and examine (1) the adherence to the seven key features of the CO-OP approach, (2) technology delivery process, and (3) participants and SOs’ receptiveness to the tele-rehabilitation delivery format.

For objective two, the participants’ and the SOs’ performance and satisfaction ratings captured on the primary outcome measure, COPM, were compared for trained and untrained goals. A clinically significant change is indicated if there is a minimum of 2-point change on the COPM performance or satisfaction ratings (Law et al., 1998). The total number of improved trained and untrained goals based on performance and satisfaction ratings were calculated at post-intervention and at 3-months follow-up; changes were in comparison with ratings from pre-intervention. Clinically significant gains were considered an indication of skill acquisition. Improvement in untrained goals would imply transfer of learning and the
maintenance of the number of improved goals over time would indicate maintenance of learning. Generalization is indicated if the participants used the new skills or strategies learned outside of the intervention sessions, without the therapist.

Each secondary outcome measure was analyzed based on the mean scores obtained at each assessment period. Changes in the mean scores of each measure between pre and post intervention, and between pre and follow-up were examined using paired t-test to determine their significance for each participant. Changes were considered significant if \( p \)-values were \( \leq 0.05 \). PASW Statistics Version 18 was used to calculate paired t-test statistics to obtain the \( p \)-values. Ninety-five percent confidence intervals on the mean scores at each assessment phase were calculated using Microsoft Office Excel 2007.

**RESULTS**

**Participants**

Thirty-one individuals expressed interest in the study. Three were excluded as they were from outside Canada, 16 did not meet the eligibility criteria, 6 were not screened as contacts were made after the recruitment period, and 6 met the eligibility criteria. Individuals not eligible for the study were due to non-TBI related injury (3), onset less than one year (1), depression (3), communication barriers (3), executive dysfunction not indicated (1), previous CO-OP training (1), and was receiving concurrent therapy (1). Three individuals did not have access to high-speed Internet. Four people and their significant others consented to participate in the study. One of these dropped out after 4 sessions for an unspecified reason. Thus three people completed the study.

The participants’ demographic, and neuropsychological characteristics and function status are shown in table 1. All were male and had a severe TBI resulting from a motor
vehicle collision. No participant had concurrent depression and none received physical therapy or occupational therapy during the time of the study. Participant (P) 1 and P3 connected to the Internet in their home. P2 connected in a local community centre for the first 12 sessions and then participated by telephone from his home for the remaining 8 sessions.

Neuropsychological test findings were reported in the form of raw score, percentile ranks, and T-scores on table 1. Scoring, T-scores, and percentile conversions was completed based on the respected manuals and studies on the assessment tools (Benedict & Brandt, 2007; Mrazik et al., 2010; Spreen & Strauss, 1998; Strauss et al., 2006; Tombaugh et al., 1999; Tulsky et al., 1997). The T-scores were interpreted as per subscripts indicated on table 1 (referenced from Spreen & Strauss, 1998). The WAIS vocabulary subtest scores suggested that all participants had low average pre-morbid intellectual ability. The participants also had very poor verbal learning ability and memory based on the HVLT. Both P2 and P3’s Digit Span scores reflected high average attention ability and low average mental flexibility on the Oral TMT-B.

Borderline to very poor executive function was indicated for P2 and P3 based on FAS Verbal Fluency (Tombaugh et al., 1999). Executive dysfunction was indicated through the DEX for P1 (DEX=22.33) and his significant other (SO) 1 (DEX=34.67). The DEX scores from P1 and SO1 may be compared to the scores found in the study by Spikman, Boelen, Lamberts, Brouwer, & Fasotti (2010), where their healthy participants and their proxies scored 18 on the DEX. P1 only completed HVLT and WAIS Vocabulary Subtest during pre-intervention due to time and logistic issues.
<table>
<thead>
<tr>
<th>Table 1: Participants' Characteristics</th>
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<tbody>
<tr>
<td><strong>Participant 1</strong></td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>Region</td>
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<tr>
<td>Time Since Injury</td>
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<tr>
<td>Medical History</td>
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<td>Years of Education</td>
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<td>Living Situation</td>
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<td>Mobility Status</td>
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<td>Transportation</td>
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<tr>
<td>Pre-Injury Productivity Status</td>
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<tr>
<td>Current Productivity Status</td>
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<tr>
<td>Significant Other</td>
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</tbody>
</table>

**Neuropsychological Tests** – listed as raw score (percentile rank (P); T-score)

<table>
<thead>
<tr>
<th>Test</th>
<th>Participant 1</th>
<th>Participant 2</th>
<th>Participant 3</th>
</tr>
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<tbody>
<tr>
<td>HVLT total recall</td>
<td>16 (P≤0.1; T-score≤20)*</td>
<td>19 (P=2; T-score=30)</td>
<td>18 (P=1; T-score=27)</td>
</tr>
<tr>
<td>FAS Verbal Fluency</td>
<td>Not completed</td>
<td>23 (P&lt;10; T-score&lt;37**)</td>
<td>19 (P&lt;10; T-score&lt;37**)</td>
</tr>
<tr>
<td>Oral TMT-B</td>
<td>Not completed</td>
<td>51.41 seconds (P=9.25; T-score=37-43)</td>
<td>43 seconds (P=9.25; T-score=37-43)</td>
</tr>
<tr>
<td>WAIS-III Digit Span</td>
<td>Not completed</td>
<td>17 (P=50; T-score=50)</td>
<td>19 (P=75; T-score=57)</td>
</tr>
<tr>
<td>WAIS-III Vocabulary</td>
<td>34 (P=16; T-score=40)</td>
<td>31 (P=25; T-score=43)</td>
<td>27 (P=16; T-score=40)</td>
</tr>
</tbody>
</table>

* T-scores may be interpreted as follows: 1–30=very poor; 31–36=borderline impairment; 37–43=low average; 44 and higher=average and above average (Spreen & Strauss, 1998)

**Based on the participants’ ages and education, the lowest available normative data is for a raw score of 30, which correlates with the 10th percentile, the normative mean for their age and education is a score of 44.7 (Tombugh, Kozak, & Rees, 1999)
Objective 1

To address objective 1, exploring the feasibility of implementing the CO-OP approach over the Internet, three sub-objectives were examined: (a) adherence to the 7 key features of the CO-OP approach, (b) technology delivery, and (c) receptiveness of the participants and the significant others on the tele-rehabilitation format and the approach.

A) Adherence to the 7 Key Features of the CO-OP Approach

The 7 key features: client-chosen goals, cognitive strategy use, guided discovery, parent / significant other involvement, intervention format, dynamic performance analysis, and enabling principles (Polatajko & Mandich, 2004), were addressed and mostly adhered to based on the feedback interviews and the field notes kept by the therapist. Adherence to each of these features is discussed below.

Client-Chosen Goals

Client-chosen goals were developed and they provided the context from which the strategies were learned using the COPM. This study, like the Dawson et al. (2009) study completed with adults post TBI did not use the Performance Quality Rating Scale. The time needed to develop the client-chosen goals was 2 to 5 hours. However, continual refinement still occurred after the initial goals were developed; P1 was refining his goals up to session 11 and P3 developed a new goal in session 11.

Cognitive Strategy Use

Cognitive strategy use in the forms of global and domain-specific strategies was a focus of the CO-OP approach in this study. Participants reported continual use of the global strategy, Goal-Plan-Do-Check, at 3-months follow-up. At the follow-up interviews, P1 provided the
example of using it to wake up early to complete work and P2 reported he has been using it when shaving every morning. At post-intervention interview, P3 reported that he found the global strategy helpful and that he has shared the strategy with his sister and physician, and stated “I think it’s, it was helpful … I can be more flexible in the way I do things as long as I stick to the Goal-Plan-Do-Check, I can be, I can still be flexible but be structured as well. And so that helped me.”

The use of cognitive strategies was further demonstrated from the therapist’s field notes, which showed that domain specific strategies were also developed and used by all participants; for example, P1 explored different memory aid options to help him recall his appointments. His previous compensatory strategy tool, an electronic organizer, was damaged during the intervention period, thus he explored and discovered new interim strategies to help recall his appointments before another organizer was purchased. P1 discovered the domain specific strategies of note taking on paper and on his hand to be helpful. P2 discovered that he could apply the domain specific strategy that he has used successfully to don his short-sleeve shirt for his long-sleeve shirt and jacket; he called this transferrable strategy his “master plan.” He reported continual use of the strategy outside of the sessions to maintain his newly acquired independence with upper body dressing every morning. P2 did not identify using specific strategy to aid dressing prior to the intervention. P3 reported the use of a monthly calendar as his pre-intervention domain specific strategy to help him keep track of his appointments and due dates. During the CO-OP sessions, he discovered the need to set short-term plans with specific timeline to help him achieve his goal of completing his various paperwork. He then adapted his use of the calendar to include the timeline of his short-term plans to facilitate timely completion of his plans and goal.
Guided Discovery

Supervisors’ feedback from the review of session recordings and the review of field notes indicated that guided discovery was adhered to during the intervention. During the intervention sessions, instead of telling the participants what to do, the therapist asked questions to promote the participants to develop strategies and plans. For example, P2 wanted to put on his socks independently. When P2 could not identify a plan, without providing a solution, the therapist asked questions to guide P2 and his SO to generate plans and strategies. At the end of one session, P2 independently verbalized a plan to use equipment to put on his socks and made plans with his SO to visit an adaptive aid supplier.

Parent / Significant Other Involvement

Significant others were involved in this study. All SOs participated in an initial joint intervention session and their subsequent involvements were based on the participants’ identified plans. This aimed to foster the participants to take on an active role in formulating plans that were used to guide inclusion of the SOs in and outside the sessions. In this pilot study, SO1 attended 2 sessions and missed 2 sessions; SO2 attended all 20 sessions; and SO3 attended 3 sessions. Although all SOs reported that it would be helpful for them to be involved, challenges were reported that have limited their participation. Some of the challenges identified by the SOs were: limited availability to meet with the participant during or after the sessions, long standing habit to tell participant what to do and found the guided discovery approach frustrating, and the need to spend time to engage others in the household to provide a private setting for the participant during the intervention sessions.
**Intervention Format**

The overall intervention format consisting of a preparation phase to set goals, an acquisition phase to learn strategy use that also involved the completion of homework, and a verification phase to reinforce learning to promote generalization and transfer was reflected in this study for adults with TBI. However, 5 major implementation changes were identified.

First, all sessions were delivered remotely to the participants’ home except for P2 who had his first 12 sessions in a private room at a community centre. P2’s last 8 sessions were at home using the telephone due to transportation issues. High speed Internet was not available where he lived. Second, the number of sessions was changed to simulate Dawson, et al. (2009) study, where 20 intervention sessions were provided twice weekly in 10 weeks. However, P1 required a longer time to set goals and thus resulted in a total of 22 sessions that were delivered over 14 weeks. Goal refinement continued for some participants during the intervention process, thus, the total number of sessions listed here included the goal setting sessions. P2 and P3 had a total of 20 sessions; they occurred over 10 weeks for P2 and 17 weeks for P3. Health and personal reasons contributed to the extended number of weeks involved. P3 had to reschedule 12 sessions, including a 1-month interruption after session 8. Third, the COPM was administered at intervention session 1 and not at a pre-meeting. Goal setting would continue onto the next session as needed. As per original protocol, the global strategy, Goal-Plan-Do-Check, was introduced after goals were identified. In this study, P2 and P3 began to practice using the global strategy on their goals in session 3 and P1 began in session 5. Fourth, the material used in this study involved a binder that contained a goal-plan-do-check strategy page and goal forms. The strategy sheets, plan lists, puppet, and stickers that are suggested in the original protocol were not used. Last, explicit
generalization training to promote strategy use outside of the sessions was implemented at each session.

*Dynamic Performance Analysis*

Dynamic performance analysis (DPA) was completed through remote observation and dialogues in the tele-rehabilitation format. DPA could not solely rely on in-person observation of the individuals’ performance or a full observation of the context or environment in which the performance occurred. Some goals were completed mostly through verbal exchange, such as P3’s goal of finding paid employment. Sessions involved mostly discussions in the format of Goal-Plan-Do-Check. However, observable “checks” were identified by P3 to mark the completion of his plans and to help facilitate the development of the next steps. Examples of P3’s “checks” included emailing his old resume to the therapist and to show the therapist a sealed envelope over the webcam to show the completion of a plan he had made.

For some goals, the therapist had to rely on observation and inputs from the participants and the SOs to complete the DPA. Angle of view and clarity of image through the webcam were limited and repositioning of the webcam was not always possible. For goals such as transfer and dressing, the therapist had to ask questions to prompt the participants and the SOs, if available, to observe and provide the necessary information to guide DPA. In some cases, privacy issues would not allow observation to occur over the Internet, such as the goal of toileting. During the telephone sessions with P2, the therapist had to rely totally on verbal dialogues to ask questions to facilitate the participant and his SO to observe, evaluate, problem solve, and plan.
Enabling Principles

The enabling principles direct the facilitators in the CO-OP approach to make the sessions fun and to promote learning, independence, generalization, and transfer. These principles were complied with through the therapist’s celebration of successes and the provision of encouragements to foster a fun learning environment. Homework was used to promote generalization and transfer. Homework sometimes consisted of repeating plans that they have successfully completed during the session in everyday life. As part of participant 2’s homework, he was to apply his plans in the morning during dressing. His reported success in applying his dressing plans without the therapist would suggest generalization of learning. Homework could also be plans that the participants have developed but not yet implemented during the session, such as the plan to check the calendar regularly to cue self to complete an application form by Friday.

B) Technology Delivery

All participants were first time Skype™ users; they found the software and hardware setup to be acceptable and one training session to be sufficient. P1 had help from a friend to set up the equipment. Staff at the community centre set up the equipment for P2; his SO set up a speakerphone at home for the later sessions. P3 set up the program and equipment independently. Only P1 used the webcam and headset provided; the other 2 participants already had the necessary equipment for the study.

No sessions were cancelled due to technical issues; however, Skype™ and Pamela for Skype™ were not consistently reliable. The numbers of sessions with video and / or audio disruptions were 3 sessions for P1, 5 sessions for P2, and 10 sessions for P3. The reason for disruption was unknown in some cases and in others a poor Internet connection was
indicated. The disruptions led to the need to repeat the verbal exchange at the time and freeze or delay in video transmissions during the sessions. Video-recordings were not continuous for any of P1’s sessions, but P2 and P3 only had one interrupted recording each. There was one interruption due to a computer related issue that was unrelated to the software or the interface used. One participant and SO indicated the need to enhance sound and video quality during feedback interviews. This participant preferred to use the speaker on his personal computer rather than the headset.

C) Receptiveness to the Tele-Rehabilitation Format and the Approach

Participants’ and the significant others’ feedback on the tele-rehabilitation format was positive. All participants and SOs reported they would suggest tele-rehabilitation format to other people. P2, who received some sessions over the telephone, found telephone sessions just as good as the videoconferences. SO2 also reported the telephone was working well but that having videoconferences at home rather than teleconferences or videoconferences at the community centre would have been preferred. P3 and his SO found eye-to-eye contacts over the video important. Two participants reported videoconference over the Internet was comparable to face-to-face therapy. All SOs and 1 participant reported receiving therapy over the Internet was acceptable but would prefer face-to-face intervention. All participants reported they would receive Internet-based therapy again if available.

The participants and SOs identified several aspects they saw as important during their feedback interviews: communication with legitimate personnel, exchange did not invade privacy, availability of private space for the videoconferences, and participation in the intervention at home.
All participants reported they were using the global strategy beyond the sessions demonstrating their receptiveness to the use of the approach. One SO suggested that poor memory might have led to difficulties in using the approach but the SO reported that the participant “loved” the sessions. P3 and his SO suggested the addition of intermittent intervention sessions after the 10 weeks training to help the participant to “stay on track.” The receptiveness to the approach may also be seen in a statement that was made by P3, “I'm actually using some of these things that we are using, that we're talking about implementing it in my day-to-day life. And you know, making the notes, putting them on the calendar, and setting like a time frame, and I think that was a that's a good thing.”

**Objective 2**

Can the CO-OP approach in its tele-rehabilitation format promote community integration and help manage executive dysfunction in adults with TBI.

*Primary Outcome Measure - COPM*

The goals developed by the participants using the COPM are listed in table 2. Summaries of the total number of improved goals based on the COPM performance and satisfaction ratings are presented in table 3.

SO1 reported improved performance and satisfaction in some trained goals at post-intervention. P1 reported improved satisfaction in some trained and untrained goals but limited improvement in performance at post-intervention. At follow-up, goal improvement based on both performance and satisfaction ratings were reported by P1, although he continued to have more goals with improved satisfaction than with improved performance at follow-up. SO1 follow-up data was unavailable.
SO2 ratings indicated improvement in both trained and untrained goals at post-intervention. P2 reported improved performance in both trained and untrained goals but only trained goals showed improved satisfaction. The majority of the trained and untrained goals developed at pre-intervention showed improvement at follow-up. However, none of the untrained goals developed at post-intervention showed change at follow-up. The majority of SO3 post-intervention ratings improved at post-intervention for both trained and untrained goals. However, P3 reported improved performance in some of his trained goals but no improved performance was indicated in the untrained goals nor did his satisfaction with any of his goals showed improvement. P3’s and his SO’s follow-up data was not available.

Table 3 shows the totals and proportions of improved trained and untrained goals. Overall, a greater proportion of trained goals than untrained goals showed improvement at both post-intervention and at follow-up. A greater number of trained and untrained goals showed improvement at follow-up compared to post-intervention.

The untrained goals identified at post-intervention were mostly unchanged. Although improvement was made in some of the goals at post-intervention, the majority of the goals were not fully achieved when these new goals were identified. Guidance was required to help the participants go beyond the list of goals set at pre-intervention to identify additional problems for the development of three new goals. The importance ratings on these goals were generally lower than the goals developed at pre-intervention and some might be considered longer-term goals. The performance ratings for each goal are reported in appendix G and satisfaction ratings are reported in appendix H.

There are missing data on the COPM. SO1 moved out of the country after the intervention, thus, follow-up data was not included. P3 was only available to complete 1 of 3
assessment sessions at post-intervention and follow-up was not completed with P3 and his SO due to health reason.

Table 2: Participants’ Self-Identified Goals

<table>
<thead>
<tr>
<th>Goals identified at pre-intervention</th>
<th>Participant 1</th>
<th>Participant 2</th>
<th>Participant 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Trained Goals</strong></td>
<td>1. Be more mobile</td>
<td>1. Dress myself</td>
<td>1. Find paid work</td>
</tr>
<tr>
<td></td>
<td>2. Better organize my day</td>
<td>2. Use the toilet by myself</td>
<td>2. Take course</td>
</tr>
<tr>
<td></td>
<td>3. Find leisure activity to do</td>
<td>3. Get off the chair with no assistance</td>
<td>3. Exercise and relax</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4. Complete 4 sets of paperwork for self and family</td>
</tr>
<tr>
<td><strong>Untrained Goals</strong></td>
<td>1. Exercise and walk at the gym</td>
<td>1. Sleep through the night</td>
<td>1. Cook for my wife</td>
</tr>
<tr>
<td></td>
<td>2. No fall in one week</td>
<td>2. Help my daughter</td>
<td>2. Sleep better</td>
</tr>
<tr>
<td><strong>Additional goals identified at post-intervention</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Untrained Goals</strong></td>
<td>1. Do laundry by myself</td>
<td>1. Type 100 words per minute on the keyboard</td>
<td>1. Quit smoking</td>
</tr>
<tr>
<td></td>
<td>2. Do grocery shopping by myself</td>
<td>2. Find computer-related paid work</td>
<td>2. Complete a volunteer work project</td>
</tr>
<tr>
<td></td>
<td>3. To fit things into my schedule</td>
<td>3. Take a course</td>
<td>3. Prepare photos to sell</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 3: Total Number of Improved Goals on the COPM

### Number of Improved Goals Based on Performance Ratings

<table>
<thead>
<tr>
<th>Trained Goals</th>
<th>Self Rating</th>
<th>Significant Other’s Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Post</td>
<td>Pre-Follow-Up</td>
</tr>
<tr>
<td>Participant 1</td>
<td>0/3</td>
<td>2/3</td>
</tr>
<tr>
<td>Participant 2</td>
<td>3/3</td>
<td>3/3</td>
</tr>
<tr>
<td>Participant 3</td>
<td>2/4</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>5/10</td>
<td>5/6</td>
</tr>
</tbody>
</table>

### Untrained Goals Set at Pre-Intervention

| Participant 1 | 1/2 | 0/2 | 0/2 |
| Participant 2 | 1/4 | 4/4 | 2/4 |
| Participant 3 | 0/2 | -   | 1/2 |
| Total         | 2/8 | 4/6 | 3/8 |

### Untrained Goals Set at Post-Intervention

| Participant 1 | 1/3 |
| Participant 2 | 0/3 |
| Participant 3 | -   |
| Total         | 1/6 |

### Number of Improved Goals Based on Satisfaction Ratings

<table>
<thead>
<tr>
<th>Trained Goals</th>
<th>Self Rating</th>
<th>Significant Other’s Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Post</td>
<td>Pre-Follow-Up</td>
</tr>
<tr>
<td>Participant 1</td>
<td>2/3</td>
<td>3/3</td>
</tr>
<tr>
<td>Participant 2</td>
<td>3/3</td>
<td>3/3</td>
</tr>
<tr>
<td>Participant 3</td>
<td>0/4</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>5/10</td>
<td>6/6</td>
</tr>
</tbody>
</table>

### Untrained Goals Set at Pre-Intervention

| Participant 1 | 2/2 | 2/2 | 0/2 |
| Participant 2 | 0/4 | 3/4 | 1/4 |
| Participant 3 | 0/2 | -   | 1/2 |
| Total         | 2/8 | 5/6 | 2/8 |

### Untrained Goals Set at Post-Intervention

| Participant 1 | 3/3 |
| Participant 2 | 0/3 |
| Participant 3 | -   |
| Total         | 3/6 |

*Please note:* Improved goals are based on a minimum increase of 2-points on the COPM ratings for performance and satisfaction. Participant 1’s significant other’s follow-up data, and participant 3 and his significant other’s follow-up data are not available.
Secondary Outcome Measures

The mean scores of the secondary outcome measures are presented in table 4 for the participants and in table 5 for the significant others. The 95% confidence intervals, mean values at each assessment phase, the pre-post p-values, and the pre-follow-up p-values are included in the tables. Only one set of scores was available for participant 3 at post-intervention. This one set of scores was used as the mean scores to obtain the pre-post p-values for all secondary outcome measures for participant 3.

The pre, post, and follow-up scores of MPAI-4 Participation Index, DEX, QOL, and LSQ are summarized in Appendix I. Paired sample t-tests were completed for MPAI-4 Participation Index, DEX, and QOL and their outcomes are presented in Appendix J.

MPAI-4 Participation Index

A decrease in MPAI-4 participation index scores implied greater participation and independence in community living. The change in P1, P2, SO1, and SO3 reached significance at post-intervention (p=.02, .05, .04, .01 respectively). P1 and P2 score increased slightly at follow-up but continued to be less than at pre-intervention. SO2 scores showed a decrease from pre-intervention to follow-up but this change was not statistically significant.

DEX

A decrease in the DEX scores reflects a decrease in the impact of executive dysfunction symptoms on everyday life. All participants’ DEX scores and most SO’s scores decreased from pre-intervention to follow-up. The change in P1’s scores approached significance at post-intervention (p=0.08) and reached significance at follow-up (p=0.03). The change in
P2’s scores approached significance at follow-up (p=0.08) and the change for P3 was significant at post-intervention (p=0.02). Most SOs reported a decrease in DEX scores with this change nearing significance for P1 at follow-up (p=0.06) but SO2’s DEX score returned to pre-intervention level at follow-up.

**QOL**

Decreased QOL scores reflects a greater number of needs were met. P1 and P3 showed a decrease in QOL scores and the change for P3 reached significance (p=.05) at post-intervention. However, P2 showed an increase in QOL scores from pre-intervention to follow-up, reaching significance in a negative direction at post-intervention (p=.02) and his score at follow-up approached significance (p=.06). Looking at participant 2’s QOL scores more closely, 2 areas that reflected the most changes were on close relationship and learning by attending school or acquiring knowledge.

**LSQ**

Greater scores on the LSQ indicate greater distance travelled. Only P2 and P3 completed the LSQ. The LSQ scores mostly remained unchanged at a score of 8 in all assessment phases for both participants and thus t-test was not performed. A score of 8 implies that P2 and P3 had been to places further than 35 km from their homes but not beyond their provinces.
Table 4: MPAI-4-P, DEX, & QOL - Participants

<table>
<thead>
<tr>
<th></th>
<th>Pre Mean</th>
<th>95% CI</th>
<th>Post Mean</th>
<th>95% CI</th>
<th>Pre-Post p-value</th>
<th>Follow-Up Mean</th>
<th>95% CI</th>
<th>Pre-Follow-Up p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MPAI-4-P</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participant 1</td>
<td>33.33</td>
<td>6.23</td>
<td>27.00</td>
<td>7.42</td>
<td>.02**</td>
<td>29.67</td>
<td>3.27</td>
<td>.51</td>
</tr>
<tr>
<td>Participant 2</td>
<td>61.00</td>
<td>-</td>
<td>52.33</td>
<td>3.97</td>
<td>.05**</td>
<td>54.33</td>
<td>5.35</td>
<td>.14</td>
</tr>
<tr>
<td>Participant 3</td>
<td>53.33</td>
<td>2.36</td>
<td>51.00</td>
<td>-</td>
<td>.19</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>DEX</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participant 1</td>
<td>22.33</td>
<td>6.23</td>
<td>11.67</td>
<td>3.46</td>
<td>.08</td>
<td>8.67</td>
<td>1.73</td>
<td>.03**</td>
</tr>
<tr>
<td>Participant 2</td>
<td>22.67</td>
<td>7.53</td>
<td>11.00</td>
<td>1.96</td>
<td>.12</td>
<td>11.00</td>
<td>1.13</td>
<td>.08</td>
</tr>
<tr>
<td>Participant 3</td>
<td>41.33</td>
<td>1.31</td>
<td>36.00</td>
<td>-</td>
<td>.02**</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>QOL</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participant 1</td>
<td>99.33</td>
<td>38.03</td>
<td>67.00</td>
<td>11.98</td>
<td>.22</td>
<td>62.33</td>
<td>29.19</td>
<td>.35</td>
</tr>
<tr>
<td>Participant 2</td>
<td>88.33</td>
<td>12.46</td>
<td>116.33</td>
<td>11.33</td>
<td>(.02**)</td>
<td>123.00</td>
<td>10.18</td>
<td>(.06)</td>
</tr>
<tr>
<td>Participant 3</td>
<td>163.33</td>
<td>17.69</td>
<td>125.00</td>
<td>-</td>
<td>.05**</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

** = Significant change (p<0.05 is considered significant)
( ) = Direction of change negatively
* = data not available
CI=confidence interval
MPAI-4-P=Mayo-Portland Adaptation Inventory-4 Participation Index (lower score indicates greater participation)
DEX=Dysexecutive Questionnaire (lower score indicates less executive dysfunction symptoms)
QOL=Flanagan’s Quality of Life Scale (lower score indicates greater needs are met)
*Please note:* Participant 3 only completed post-intervention assessments once. The “Post Mean” provided is the score from the one assessment session that was completed. This one score was used as the mean score to calculate the *p* values. Participant 3’s follow-up data is not available.

Table 5: MPAI-4-P & DEX - Significant Others

<table>
<thead>
<tr>
<th></th>
<th>Pre Mean</th>
<th>95% CI</th>
<th>Post Mean</th>
<th>95% CI</th>
<th>Pre-Post p-value</th>
<th>Follow-Up Mean</th>
<th>95% CI</th>
<th>Pre-Follow-Up p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MPAI-4-P</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Significant Other 1</td>
<td>47.33</td>
<td>1.31</td>
<td>40</td>
<td>1.96</td>
<td>.04**</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Significant Other 2</td>
<td>63.00</td>
<td>12.45</td>
<td>61.33</td>
<td>5.35</td>
<td>.71</td>
<td>57.67</td>
<td>4.57</td>
<td>.51</td>
</tr>
<tr>
<td>Significant Other 3</td>
<td>47.67</td>
<td>0.65</td>
<td>43.33</td>
<td>0.65</td>
<td>.01**</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>DEX</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Significant Other 1</td>
<td>34.67</td>
<td>4.28</td>
<td>29.33</td>
<td>1.73</td>
<td>.06</td>
<td>-</td>
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<tr>
<td>Significant Other 2</td>
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<td>4.57</td>
<td>.93</td>
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** = Significant change (p<0.05 is considered significant)
CI=confidence interval
MPAI-4-P=Mayo-Portland Adaptation Inventory-4 Participation Index (lower score indicates greater participation)
DEX=Dysexecutive Questionnaire (lower score indicates less executive dysfunction symptoms)
*Please note:* Significant other 1 and 3 follow-up data is not available.
**DISCUSSION**

To our knowledge, this is the first study to examine a tele-rehabilitation-based meta-cognitive training to address executive dysfunction post-TBI. The study also is unique in that all assessments and interventions were completed remotely with the participants with TBI and their significant others. Significant others and each participant were involved in the intervention process as part of the CO-OP protocol and their participation in the assessment process was used to provide another perspective to the participants’ progress.

The implementation of this Internet-based meta-cognitive training was demonstrated to be feasible, able to facilitate improvement in trained goal performance. Some evidence for transfer was found with improvement on untrained goals improvements in community integration, and the impact of executive dysfunction in everyday life. These data, though preliminary, are very encouraging.

**Objective 1: Explore the feasibility of administering the CO-OP approach via a tele-rehabilitation format**

The implementation of the CO-OP approach through the Internet was found to be feasible as it mostly adhered to the 7 key features of the CO-OP approach, the technology used was reported to be acceptable by the users, and the technology used was sufficient in most sessions. Some of the adaptations to the 7 key features of the CO-OP protocol were aimed to better meet the needs of adults with TBI by having a longer intervention period and to foster the participants to take on a more active role in involving their SOs during the intervention.

Although the therapist had to analyze the participants’ performance, thus completing DPA, to allow her to guide the participants to learn and develop strategies during the
sessions, the use of videoconference did create some challenges and which may need to be considered in future studies.

First, videoconferencing may have limited the amount of information that the therapist could observe. The therapist could not see the complete context in which the activity was performed, the participant could not always bring the webcam to a different room or to allow a better view at another angle, and the video quality did not always allow clear observation of performance. In such cases, the therapist needed to combine observation with information provided by the participants and, in some cases, the significant others through verbal dialogues to allow sufficient information to be gathered for analysis.

Second, the need to rely in parts or solely on verbal exchange during analysis posed another challenge for the therapist. The accuracy of the information provided was at times questionable and may have lead to development of misinformed or unsuccessful plans. However, it also provided another opportunity for the therapist to ask questions to promote the participants to self-observe and self-evaluate their performances and surroundings. As the process of the CO-OP approach aims to facilitate the participants to discover their strategies to accomplish their goals, promoting the participants to self-monitor and evaluate may contribute to the CO-OP process. Without a full understanding of the situation, it may have taken a longer period for the therapist to guide the participants to examine their performance and to discover a potentially workable plan.

Third, the longer time period that may be needed for the participants to discover successful plans might be reflected in the limited number of improved goals at post-intervention and the increased number of improved trained and untrained goals at follow-up. This study showed an increased number of improved goals over time, whereas the number of
improved goals was mostly unchanged from post-intervention to follow-up in Dawson et al. (2009) study. Rather a change in intervention format and perhaps the addition of booster sessions may facilitate greater gains and generalization over time may be considered in future studies.

Fourth, how and how often the SOs are involved may have influenced the analysis, intervention process, and outcome. SO2 was involved in every session and she took on some of the facilitator role from the therapist as the training progressed. P2 had the most number of improved trained and untrained pre-intervention goals at follow-up. However, although P3 did not report a high number of improved goals, his SO indicated that most of his goals did improve and she only participated in 3 training sessions. It might be that P2 needed physical assistance to perform his goals at baseline, and thus, SO involvement was needed to trial his plans during the sessions and could have promoted carry over of the plans beyond the training sessions resulting in greater gains. Whereas P3’s goals related more to establishing strategies that he needed to implement himself. Although some of his plans did involve and affect his family, their involvements were dependent on his ability to initiate and implement the strategies at the particular situations outside the sessions. Perhaps, the level of SOs’ involvement may need to vary depending on the particular goals developed and the participants’ physical and cognitive abilities to follow through with the plans.

However, regardless of the differences in the level of SOs' involvement, their understanding of the approach to sufficiently provide guidance outside the sessions and / or to provide positive reinforcement as the participants implement their plans and strategies may have been an important part of the process. Determining the optimal frequency or intensity
of SOs’ involvement for an individual with TBI is beyond the intent of this study and will benefit from future research.

Fifth, few neuropsychological assessments were available to administer over the Internet and thus limiting the scope of cognitive characteristics that were examined in this study. Also, the normative data on the available tools when the tools are administered in a remote format will need further examination. The development and validation of assessment tools for remote administration will be beneficial to enhance tele-rehabilitation research and practice.

Sixth, the technology used could be improved. When examining the technology used in this study, the installation of the hardware and the software program, the use of the interface, and the participation in therapy over the Internet were reported to be acceptable to the participants. Similar to the study by Bergquist et al. (2009), only one training session was provided and the participants were asked to install the program at home. However, in their study, the training was completed in a face-to-face format and their participants installed the program from a CD-ROM. In our study, training was completed remotely and a web-link was provided for software installation.

Most sessions in this study did not have technology issues and no session was cancelled due to technical problems. However, the freezing of the videos during some sessions or audio interruptions was distracting to the participants. It was unclear if the technology-related interruptions were related to the reception at the participants’ or the therapist’s locations or if it was program related. Other tele-rehabilitation studies have also commented on the need of better transmission speed and quality in their studies (Tam et al.,
Further exploration and development of cost-effective quality interface for tele-rehabilitation would be beneficial.

Finally, the need of high-speed Internet did limit some interested individuals from participating in the study. Based on the individuals recruited, the incompletion rate of this study was 1/4 (25%). This is less than the tele-rehabilitation studies by Bergquist et al. (2009) (33%), but greater than the face-to-face study on the rehabilitation of executive dysfunction also with adults with TBI by Rath, Simon, Langenbahn, Sherr, and Diller (2003) (about 20%). To better determine if the delivery format has affected the completion rate, a study with a larger sample size would be beneficial.

However, from the three participants that completed the program, it appeared that the approach and the technology used were acceptable. The key features of the CO-OP approach were mostly adhered to. The participants were able to learn to apply the global strategy and to discover domain specific strategies to help them progress in their goals. Some of the participants have used domain specific strategies or compensatory strategies prior to the study. Whether the level of pre-intervention strategy use has influenced the participants’ learning and successes is an area that may be worth exploring in future studies using a more structured approach. The findings from this study suggest that it may be feasible to administer the CO-OP approach remotely through videoconferences with adults with TBI.
Objective 2: Examine if the CO-OP approach in its tele-rehabilitation format can promote community integration and help manage executive dysfunction in adults with TBI

The CO-OP approach in its tele-rehabilitation format demonstrated the ability to facilitate community integration and a trend towards decreased executive dysfunction experienced by the participants.

All participants reported improvement in performance and satisfaction on the COPM after receiving the CO-OP training, resembling our previous findings (Dawson et al., 2009, 2010). In both the current study and our previous work, more improvement was noted on trained goals compared to untrained goals. In this pilot study, a greater number of goals showed improvement at follow-up than at post-intervention; this is different than in our previous work (Dawson et al., 2009) where the number of improved goals were generally maintained at follow-up. However, the proportion of improved goals at post-intervention in the previous study was greater than in this study. This might suggest that participants receiving the intervention in a tele-rehabilitation format might require a longer time period to demonstrate performance change in their goals. By follow-up, almost most trained and untrained goals developed at pre-intervention showed improvement in the tele-rehabilitation study, demonstrating transfer of the approach.

However, untrained goals that were developed at post-intervention in this study were mostly unchanged. This may be related to the total number of goals that the participants were expected to address between post-intervention and follow-up. Although some of the pre-intervention goals showed improvement at post-intervention, these goals were not fully achieved. Thus, when the participants set their post-intervention goals, the participants
would then have at least 8 goals to address at once. Other than the number of goals, how
generalization and transfer were facilitated and the time allotment between evaluations may
also have led to the mostly unchanged post-intervention goals. One potential solution may
involve the addition of booster sessions to continue to provide explicit generalization and
transfer training over a longer time frame.

As in our previous work, the CO-OP approach in its tele-rehabilitation format also
appeared to positively enhance community integration, improve the influence of executive
dysfunction on everyday life, and the participants’ quality of life. Significant improvement
in community integration was found on the MPAI-4 participation index in 2 of 3 participants
and 2 of 3 SOs’ ratings at post-intervention. All participants showed a trend towards fewer
executives dysfunction symptoms experienced and these changes were found to be
significant in 2 participants on the DEX; one at post-intervention and one at follow-up. The
DEX scores of P1 and SO1 almost reached significance at post-intervention and P2 almost
reached significance at follow-up.

A significantly better quality of life at post-intervention was reported by P3, and P1
showed a trend towards better quality of life although it did not reach significance. However,
despite having significantly better community integration at post-intervention and the highest
number of improved goals among the participants, P2 reported a decrease in quality of life
over time. Several potential explanations may be drawn. SO2 reported P2’s memory was
improving and that greater initiation in attempting to participate in activities around the
home. His improved memory and his greater participation in everyday tasks might have
provided opportunities for him to develop insight into his limitations and the potential
challenges that he may have in achieving his goals. This may result in the change in
perception or recognition that his needs were not as well met. The reported decreased
socialization and learning opportunity on the QOL might also be related to the change in
intervention settings, from visiting the community centre twice weekly to receiving the
intervention at home, or perhaps the discontinuation of the CO-OP program itself. Thus,
although 2 of 3 participants reported improvement on the QOL, the relationship between
quality of life and the CO-OP approach will benefit from further exploration.

The limited significance found on the MPAI-4, QOL, and SO’s DEX at follow-up
may not be surprising. A randomized control trial that examined the treatment of
multifaceted strategy training for executive dysfunction post acquired brain injury, also noted
insignificance gains at follow-up for DEX proxy’s scores and on their quality of life
measures (Spikman et al., 2010). However, their follow-up period was at 6-months, double
the follow-up period of this study. Future studies will be needed to examine how community
integration, quality of life, and the influence of executive dysfunction on everyday life may
be maintained post intervention and to examine if booster sessions may help address this.

Limitations

Several limitations need to be considered in this pilot study. First, the study was small and
some follow-up data were not available due to the participants’ and the SOs’ life
circumstances. Although this limits our ability to draw substantive inferences from these
data, the preliminary data suggest that further exploration of this approach is warranted.
Second, we were limited in our ability to characterize the cognitive status of our participants,
as we could not test them in person. The remote administration of the neuropsychological
tests may have impacted the results. As more and more testing procedures provide online
administration psychometrics, this will become less of a problem. Third, although most of
the CO-OP 7 key features were adhered to, some aspects were modified, especially in its intervention format, how SOs were involved, and how information may be gathered for the therapist to complete DPA during the intervention. These variations in treatment protocol could have affected outcome. Future studies to further examine the completion of DPA over videoconferences and the influence of SOs to optimize the benefit of their involvement would be beneficial.

**CONCLUSION**

This pilot study demonstrated that delivering meta-cognitive strategy training, the CO-OP approach, using a tele-rehabilitation format is feasible and shows similar positive effects to delivering it face-to-face. Participants in this study, who had sustained severe TBI over 10 years ago, with very poor learning abilities and memory, and impaired executive function, reported gains in their self-identified trained and untrained goals suggesting skill acquisition and transfer of learning. The independent application of the skills learned in everyday life, such as the continual use of dressing strategy during daily morning routine in P2 and the use of the calendar to guide completion of plans outside of the sessions in P3, may imply generalization of learning. Improvement was also suggested in the individual’s community integration, quality of life, and how executive dysfunction symptoms may be experienced in the individual’s everyday life.

Although the small sample size limits the generalizability of its findings, the benefit of this intervention program, the CO-OP approach, may be reflected in SO2’s feedback: “the program, it has made (him) think more for himself and to come up with new ideas and that he wasn’t doing before. And then he was implementing them into his daily activities.”
Given the size of this pilot study, further research is necessary to continue to explore the tele-rehabilitation version of this meta-cognitive training approach as a tool to provide remote services to promote skill acquisition, community integration, quality of life, and to address executive dysfunction for individuals living with TBI.
CHAPTER 4: DISCUSSION

4.1 Introduction

This chapter highlights the findings from a two-part literature review and from the pilot study completed for this thesis. The objective of this study was to examine the implementation of a meta-cognitive approach through a tele-rehabilitation format to address executive dysfunction and to promote community integration in adults living with traumatic brain injury (TBI). The study’s implications, limitations, and future directions are also discussed.

4.2 Literature Review: Rehabilitation of Executive Dysfunction Post Traumatic Brain Injury

Thirty-two studies were reviewed in this literature review. When examining the common features of these studies, five areas were identified for consideration in the adult rehabilitation of executive dysfunction post TBI that could promote maintenance, generalization, and transfer. Two areas, (1) the use of everyday activity and personally relevant goals and (2) the use of meta-cognitive strategy training, resemble the recommendations made from the systematic reviews completed by Cicerone et al. (2000 & 2005) and Kennedy et al. (2008). This literature review provided additional areas to consider; (3) trainer and trainee interaction, (4) explicit generalization and transfer training, and (5) the incorporation of task-specific strategy in addition to meta-cognitive strategy training.

The trainers became the therapeutic tools or the facilitators in their interactions with the trainees to guide them to actively learn and apply the strategies taught and / or used. These guiding techniques may provide opportunities for the trainees to learn to self-monitor
and regulate their own behaviours and to minimize the dependency that may develop on the trainers for solutions. This facilitator role in turn may promote greater internalization and self-reliance on the use of the strategies taught.

Generalization and transfer of the strategies learned beyond the trained context into everyday life is perhaps the ultimate goal of many rehabilitation programs. Explicit generalization and transfer training, through techniques such as training the application of the strategy in multiple contexts, training the application in real life situations, or the use of diary and / or home practices to promote its application beyond the sessions, were mostly incorporated in studies that have reported evidence of transfer of learning (Cicerone & Giacino, 1992; Cicerone & Wood, 1987; Dawson et al., 2009; Miotto et al., 2009; Spikman, Boelen, Lamberts, Brouwer, & Fasotti, 2010; Toglia, Johnston, Goverover, & Dain, 2010). Cicerone and Giacino (1992) and Cicerone and Wood (1987) found transfer of learning only occurred in individuals who had received explicit training to promote transfer.

Task-specific or domain-specific strategies were found to be helpful in promoting improved performance in specific activities that were affected by executive dysfunction. However, transfer of learning was limited to the trained context when only domain-specific strategies were utilized (e.g., Burke et al., 1991; Ownsworth et al., 2010; von Cramon & Matthes-von Cramon, 1994). Therefore, although domain-specific strategies may be important to enhance performance in a given task, the incorporation of meta-cognitive training, explicit generalization and transfer training, and the trainer and trainee interaction also may be needed to truly promote generalization and transfer of the strategies learned in daily life.
The Cognitive Orientation to daily Occupational Performance (CO-OP) approach used in this thesis fits well with the 5 areas identified. Thus, it might be hypothesized that the approach would facilitate a positive impact on executive dysfunction symptoms that would transfer into everyday living. Through the gains made in the untrained goals developed at pre-intervention and the lowered DEX scores reported, it appeared that transfer of learning did in fact occur and that executive dysfunction symptoms in daily life were decreased. However, most of the untrained goals developed at post-intervention did not show improvement. This might suggest the need to further examine the training process to better facilitate the transfer of strategies in untrained goals post-intervention. Although all participants and most significant others reported a decrease in the DEX scores, indicating less executive dysfunction symptoms impacting everyday life, one significant other reported no change on the DEX from pre-intervention to follow-up. A larger sample size may provide a clearer perspective on the influence of the approach on the presentation of executive dysfunction in everyday life.

4.3 Literature Review: Tele-Rehabilitation for Adults with Traumatic Brain Injury

Nineteen intervention studies on the use of tele-rehabilitation with adults with TBI were included in this literature review. The interventions investigated in these studies targeted general symptom management, transition to community living (6 studies: Bell et al., 2004, 2005, 2008; McGrath, Dowds, & Goldstein, 2008; Salazar et al., 2000; Warden et al., 2000) and memory (6 studies: Bergquist, Gehl, Lepore, Holzworth, & Beaulieu, 2008; Bergquist et al., 2009; Bourgeois et al., 2007; Melton & Bourgeois, 2005; Tam et al., 2003; Turkstra & Bourgeois, 2005). Other areas of focus included analogy-based problem solving, in which
the participants were taught source problems that may be common in daily life and to draw analogies to solve other problems similar to the source problems taught (3 studies: Man et al., 2006b; Man, Soong, Tam, & Hui- Chan, 2006c; Soong, Tam, Man, & Hui-Chan, 2005), upper extremity function (2 studies: Hermens et al., 2008; Huijgen et al., 2008), and mood and emotional distress (2 studies: Bombardier et al., 2009; Bradbury et al., 2008). None of these studies examined the use of meta-cognitive training over the Internet to specifically address executive dysfunction.

The technology used in 10 of the 19 studies involved the provision of the intervention over the telephone (Bell et al., 2004, 2005, 2008; Bombardier et al., 2009; Bourgeois et al., 2007; Bradbury et al., 2008; Melton & Bourgeois, 2005; Salazar et al., 2000; Turkstra & Bourgeois, 2005; Warden et al., 2000). Videoconferencing was used in combination with specific computer-based training programs in 6 studies (Hermens et al., 2008; Huijgen et al., 2008; Man et al., 2006b, 2006c; Soong et al., 2005; Tam et al., 2003). Text messaging was used in 2 studies (Bergquist et al., 2008, 2009). Only 1 study used videoconferencing with commercially available tools and they alternated their face-to-face community visits with videoconference sessions (McGrath et al., 2008). All studies involved some component of face-to-face interaction in the assessment and / or intervention phases. None of the studies found completed all phases, including assessment and intervention, remotely over the Internet with adults with TBI as this thesis study has done. This might be due to the complexity of the technology used leading to the need for face-to-face training and / or equipment set up, or perhaps because of the types of assessments used that could only be administered in a face-to-face format.
Overall, these tele-rehabilitation studies suggest that adults with TBI were mostly receptive to the idea of receiving therapy in a tele-rehabilitation format and that tele-rehabilitation interventions may lead to similar outcomes as face-to-face interventions.

4.4 A Pilot of the CO-OP Approach in Tele-Rehabilitation

This pilot study examined if it was feasible to administer the meta-cognitive training, the CO-OP approach, remotely and to examine if this would promote community integration and helps manage executive dysfunction for adults with TBI. The findings suggested that it is feasible to administer the approach remotely. The 7 key features of the CO-OP approach was mostly adhered to, technical issues did not result in session cancellation (although there interruptions were encountered during some of the sessions), and the technology utilized was reported to be acceptable by the participants.

The findings also suggest the achievement of skill acquisition (through the improvements made in the participants’ self-identified goals) and transfer of learning (through the improvements made on some of the untrained goals). Examples of generalization of learning outside the intervention sessions were also demonstrated through the continual use of the strategies learned in the participants’ daily life. The changes made on the secondary outcome measures also suggested improvement in community integration and less influence of executive dysfunction symptoms in everyday life. These changes reached significance for some participants and significant others.

Changes made to the 7 key features were made to allow the use of videoconferences to deliver the intervention and to better meet the needs of adults with TBI, including change in the length of the intervention period, the process in which significant others were invited to be involved in the intervention, and in the materials used to help guide the learning of the
CO-OP approach. Although the therapist had to do analyses throughout the sessions to allow her to guide the participants to learn and develop strategies, obtaining the necessary information for analysis through videoconferences created some challenges. These included the amount of information that was limited by the use of videoconference, the reliance on verbal dialogue with the participants and in some cases their significant others to guide analysis and the development of plans, and the limited number of neuropsychological assessments available to use over the Internet which might have limited obtainment of a true picture of the participants’ cognitive characteristics and confirmation of the existence of executive dysfunction.

4.5 Limitations

As previously discussed, there were challenges and limitations in delivering the approach remotely. First, the amount of information that was observable over the Internet was limited. The angle of and/or quality of the video and the location of the webcam that might not be changed during the sessions limited the information available for dynamic performance analysis (DPA). In such cases, the therapist needed to rely on information from the participants and, in some cases, the significant others to allow sufficient information to be gathered for analysis.

This reliance on verbal dialogue and the participants’ observation and input posed another challenge for the therapist and may have limited the ability to deliver the approach through videoconferences. However, although accuracy of the information provided might be questioned, it also provided another opportunity for the therapist to ask questions to promote the participants to better observe and self-evaluate their performances and their surroundings. Without a better understanding of the situation, the therapist may have had to
spend a longer time to guide the participants to explore and discover potential reasons for successes or problems, and to guide them to develop their next plans. The longer time period needed for the participants to discover successful plans may be reflected in the limited number of improved goals at post-intervention and the increased number of improved trained and untrained goals at follow-up.

Another limitation of this study was the small number of neuropsychological tests that we had access to that could be administered solely through oral exchange. This restricted the scope of cognitive processes that were assessed thus affecting disallowing the capture of the full extent of cognitive impairments of the participants. It was also assumed that the normative data and psychometrics of face-to-face tests (e.g. Hopkins Verbal Learning Test) would apply when they were administered in a remote format. Research to examine this assumption will be beneficial.

Other than the neuropsychological tests, all measures were based on subjective reports and rating scales. The relationships between the participants and the significant others could influence the significant others’ perception affecting their ratings. Due to the nature of the study, direct observation of performance was not possible in most cases, thus limiting the ability to use objective functional measures. The fact that the significant others confirmed reports by participants, especially with the community integration measure, MPAI-4 Participation Index, provided evidence that the significant others’ inputs might provide another meaningful dimension of the participants’ status and performance.

Due to health and life changes, data were not available from one participant and two significant others. This limited the amount of follow-up data that was available for analysis and could have influenced the interpretation of outcome. Also, participant 3 was only
available to complete 1 of 3 post-intervention evaluations; the score obtained in this one session was used as the average for paired t-test calculation to obtain the p-value. However, the value used may not truly represent the participant’s average perception of his community integration, executive function, distance travelled, and quality of life during the 3-weeks of post-intervention period.

The lack of high-speed Internet access in participant 2’s home limited his ability to receive videoconferences sessions creating discrepancies in the intervention formats between the participants. The use of an unfamiliar setting for videoconferencing and the lack of video exchange when the setting was changed to home might have influenced performance, analysis, and learning. However, participant 2 continued to progress in his goals despite the change in the settings and mediums used, suggesting the potential of the CO-OP approach to be delivered at least partially with and without video exchange. This participant and his significant other found the use of telephone to be acceptable, but it is important to note that videoconferencing was used in the early sessions.

Finally, the study size was small (n=3) and the first 3 qualified participants recruited were all males. Participants lived in different communities and provinces in Canada. Each of their unique characteristics including the differences in the communities in which they resided limited the ability to compare or relate findings to other individuals with TBI. However, the study did show that it was feasible to deliver such training with promising outcomes.

4.6 Implications

This first study on the remote implementation of a meta-cognitive training to address executive dysfunction with adults post TBI resulted in promising outcomes, thus supporting
further research in this area. Findings suggested that the CO-OP approach delivered through a tele-rehabilitation format is feasible. However, the use of videoconference did lead to some challenges as previously discussed. Several aspects of this tele-rehabilitation based approach might be considered to help refine its protocol for remote delivery in the future.

First, the frequency of and how the significant others are involved may need to be further considered. It will also be important to establish the roles and boundaries of significant others’ involvement and how this might fit within the CO-OP protocol.

Participant 2’s significant other was involved in every session. She not only was observing but at times took on the facilitator role as the training progressed. Participant 2 had the most improved trained and untrained pre-intervention goals at follow-up. Although participant 3 did not report a high number of improved goals, his significant other indicated that most of his goals did improve and she only participated in 3 training sessions. It might be that participant 2 needed physical assistance from his significant other to perform the activities, and thus, the involvement of his significant other was needed to allow him to trial his plans. This may have promoted carry over of the plans beyond the training sessions resulting in greater gains. Whereas participant 3’s goals related more to establishing strategies that he would need to implement to accomplish his goals, some of his plans did involve and affect his family. His family members’ involvement was dependent on his ability to initiate and implement the strategies in the particular situations outside the sessions. Thus, it appeared that the significant others’ level of involvement may depend on the particular goals developed and the participants’ physical and cognitive abilities to complete the plans. The therapist may need to assess and determine the level of significant others’ involvement on a case-by-case basis.
However, regardless of their level of involvement, the significant others’ understanding of the approach to sufficiently provide the needed guidance outside the sessions and/or to provide positive reinforcement as the participants implemented their plans and strategies outside the sessions may be an important part of the process. As per the original CO-OP protocol, having a minimum of three mandatory sessions with the participants and their significant others together might provide opportunities for the therapist and the participants to assess and determine the significant others’ roles and level of involvement in future sessions. These joint sessions might also provide opportunities for the significant others to learn the approach. To facilitate generalization and transfer of learning and maintenance after the intervention, allowing the significant others’ involvement to go beyond that of observer to that of facilitator might also be beneficial in some cases. The therapist’s ability to assess and guide the development of the sessions and the involvement of the significant others may benefit from experience and training.

Second, all participants reported they would be willing to try tele-rehabilitation again. The interest in tele-rehabilitation may also be reflected through the 31 individuals who have expressed interest to participate in this study. This pilot study was intended to only include a very small sample size and to exclude individuals with non-TBI diagnoses and depression. The use of neuropsychological tests as an inclusion criteria also might have led to exclusion of individuals with executive dysfunction that were not captured based on the limited tests available for remote administration. Further exploration of available tools and the development and validation of neuropsychological tests for use over the Internet will be helpful. Future studies with a larger sample size that include individuals with TBI and ABI
diagnoses will provide a broader perspective on the feasibility and the benefits of the CO-OP approach when administered in a tele-rehabilitation format.

Third, given the potentially longer time frame for participants to show change in their goals, follow-up intervention sessions or booster sessions may be beneficial. Whether these booster sessions or other processes are necessary or sufficient to promote transfer of learning to untrained goals developed after the initial intervention period will need to be explored. In regards to technology use, the technology would already be setup for the booster sessions from the previous training and extra costs may not be needed to do these additional sessions if the client already uses high-speed Internet regularly.

Finally, the CO-OP approach was delivered using relatively inexpensive software and hardware. This may have implications for the translation of the study in clinical practices where cost can be a limiting factor. It may also allow clients with TBI to receive training from therapists with brain injury experience when this may not be available in their community. If the participants already have the hardware and high-speed Internet at home, the completion of the study through videoconference may not add extra costs for them and would save the travel and perhaps accommodation costs to receive the service outside their communities. The setup of the technology used in this study is also relatively simple and the therapist may not need the assistance of a technology specialist to implement this program, however, the quality of transmission in this study was not always optimal and thus, exploration of other cost effective programs with encryption technology to ensure privacy of the Internet exchange may be considered for future studies.
4.7 Future Directions

This small n of 3 pilot study suggested that it was feasible to implement the CO-OP approach over the Internet and that it might promote community integration and reduce the executive dysfunction symptoms experienced by the participants. A larger study to confirm these effects will be beneficial. A bigger set of data will allow further examination of the relationship between the delivery medium, the dynamic performance analysis process, and goals. It will also provide a greater opportunity to examine the therapeutic relationships between the participants, significant others, and therapists, how this is influenced by the remote delivery format, and how this may influence outcome.

Another area that would be interesting to explore is to examine if there are underlying prerequisites that may influence individuals’ abilities to participate in the CO-OP approach remotely and how these may affect outcome. The prerequisites may be internal, such as one’s cognitive and physical status, or external, such as a significant other’s availability. An expansion of the neuropsychological tests used may allow a better examination of the cognitive characteristics of the participants. How these prerequisites may vary depending on the goals developed may also be another area for future research. Finally, examining the current process and how it may adapt to better promote maintenance and generalization and transfer of learning may be beneficial.

The preliminary data from this pilot study aimed to inform future research on the CO-OP approach and tele-rehabilitation intervention studies to promote community integration of individuals with executive dysfunctions post TBI.
CHAPTER 5: SUMMARY & CONCLUSION

This study is the first to implement meta-cognitive strategy training, the Cognitive Orientation to daily Occupational Performance (CO-OP) approach, in a tele-rehabilitation format to address executive dysfunction in adults post traumatic brain injury (TBI). To the author’s knowledge, this is also the first intervention study with adult TBI survivors to only utilize tele-communication in both the assessment and intervention process, where no face-to-face contacts were ever made before or during the study.

The literature review completed for this study led to five areas of consideration that may guide the development and selection of intervention approaches to address executive dysfunction with adults post TBI in research and practice. These five areas: (1) trainer and trainee interaction, (2) use of everyday activity and personally relevant goals, (3) explicit generalization and transfer training, (4) use of task-specific strategy, and (5) meta-cognitive strategy training, are all features that can be found in the CO-OP approach.

From this pilot study, it was found that the remote implementation of the CO-OP approach was feasible and that the goals of the original CO-OP approach (generalization, transfer, skill acquisition, and cognitive strategies) might be met through this tele-rehabilitation format. The participants in this pilot study demonstrated the ability to learn and apply the global strategy and to develop domain-specific strategies during the intervention. Improvement in both trained and untrained goals was reported and remarkably a greater number of goals improved at follow-up compared to at post-intervention, suggesting maintenance and transfer of learning. The findings also suggested this tele-rehabilitation-based meta-cognitive training could promote community integration and
reduce the executive dysfunction symptoms experienced by the participants. All participants also reported satisfaction with this tele-rehabilitation meta-cognitive training.

In conclusion, this small pilot study provided preliminary data to demonstrate that it was feasible to implement the CO-OP approach in a tele-rehabilitation format and that the approach has the potential to promote community integration and to help manage executive dysfunction symptoms experienced by adults with TBI. However, a larger study and future research are warranted to guide further refinement of the protocol and to enhance the understanding of the CO-OP approach when delivered in a remote format to promote community integration and manage executive dysfunction in individuals living with TBI in rural Canadian communities.
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APPENDICES
## Appendix A: Skill Training Studies

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<th>Features of the Intervention(s)</th>
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<th>Follow-up</th>
<th>Effect on untrained tasks</th>
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<tbody>
<tr>
<td>Thaut, M. H., Gardiner, J. C., Holmberg, D., Horwitz, J., Kent, L., Andrews, G., et al. (2009).</td>
<td>Quasi-experimental pre and post design with control. n=54. Executive function group, n=19, was compared with control group, n=16.</td>
<td>Mixed Traumatic Brain Injury (TBI) and other Acquired Brain Injury (ABI) diagnoses. Control group: mean age=47.39 years; mean years of education 14.3; and 14.05 years post injury. Treatment group: mean age=52.65 years; mean years of education=13.48 years; and 15.18 years post injury.</td>
<td>United States</td>
<td>Neurologic Music Therapy (NMT) consisted of four 30-minutes sessions, each with a different focus: emotional adjustment, executive function, attention, and memory. Two sessions were provided on separate days in the first week followed by the other two sessions given on separate days two weeks later. Executive function session was completed in the second session of week one. Control group rested in a quiet room for 30 minutes.</td>
<td>Musical executive function training was reported to focus on individual decision making, problem solving, comprehension, and reasoning through group projects. Specific focus was placed on switching attention and performing to 2 rapidly alternating musical cues.</td>
<td>Pre and post measures specifically chosen for each targeted intervention area were done before and immediately after each session. Executive function outcome measures included Trail Making Test-Part B (to capture mental flexibility) and self-efficacy related to executive functions - both improved after training. No change found in control group.</td>
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<td>Stablum, F., Umilta, C., Mazzoldi, M., Pastore, N., &amp; Magon, S. (2007).</td>
<td>Rehabilitation of endogenous task shift processes in closed head injury patients. <em>Neuropsychological Rehabilitation, 17</em>(1), 1-33.</td>
<td>Pre and post study with 4-months follow-up, n=36. Treatment groups: (1) n=18 with brain injuries (10 severe and 8 mild), &amp; (2) n=18 without brain injuries. There was also a placebo group with n=10 with severe brain injuries.</td>
<td>Italy</td>
<td>Two-item shift condition training was provided using computer software. A total of 5 sessions were given daily for 1 week; each session consisted of 10 sequences.</td>
<td>Participants responded according to displayed information by pressing the appropriate button in response to the stimulus' position and say if the letters shown were the same or different.</td>
<td>Shift cost (the difference in reaction times in alternating runs of stimuli) of the treatment groups reached similar levels to that of the healthy control by session 5. Dual task, the Paced Auditory Serial Addition Task (PASAT), and the Behavioural Assessment of the Dysexecutive Syndrome (BADS) improved at post-test.</td>
<td>Reaction time was significantly slower than at post-test but it was significantly faster than at pre-test. PASAT and BADS continued to show maintenance of gains at 4-weeks follow-up.</td>
<td>Improvement in other aspects of executive functions was suggested based on improvement found in dual task, PASAT, and BADS.</td>
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### Appendix A: Skill Training Studies (Continued)

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<td>3 Stablum, F., Umilta, C., Mogentale, C., Carlan, M., &amp; Guerrini, C. (2000). Rehabilitation of executive deficits in closed head injury and anterior communicating artery aneurysm patients. <em>Psychological Research</em>, 63(3-4), 265-278.</td>
<td>Pre and post study with 3-months follow-up. Patient group, n=10. Healthy control group, n=10.</td>
<td>Patient group had TBI. Mean age was 25.6 years, mean years of education were 3.64, and mean months post injury was 27.8 months. Minimum months post injury was 7 months. Patient group had 9 males. The healthy control was matched in age and sex.</td>
<td>Italy</td>
<td>Computer based dual-task training was completed with both patient and healthy control groups. Sessions were once per week for 5 weeks. Each session had 1080 trials that were completed in blocks of 72.</td>
<td>Participants had to respond to stimuli displayed on the computer screen by pressing the correct key to indicate the stimulus’ location and to say aloud if the stimuli were the same or different.</td>
<td>Dual-task performance of the patient group improved to the similar level as healthy control by session 5.</td>
<td>Improvement maintained at 3-months follow-up.</td>
<td>Improvement in PASAT. Authors reported anecdotic account of improvement in untrained card game performance outside the sessions post training.</td>
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<td>4 Chen, S. H., Thomas, J. D., Glueckauf, R. L., &amp; Bracy, O. L. (1997). The effectiveness of computer-assisted cognitive rehabilitation for persons with traumatic brain injury. <em>Brain Injury, 11</em>(3), 197-209.</td>
<td>Pre and post study. Treatment group, n=20. Matched control, n=20 who received conventional therapy. The 2 groups were matched in chronicity, months between tests, and in severity (days in coma). They differ in length of treatment received.</td>
<td>All participants had TBI. Between the 2 groups, no significant difference was reported in age, education, months between tests, and length of coma. But groups differed in chronicity; 15.9 months post injury in experimental group and 6.8 months in comparison group. They also differed in the length of treatment: experimental group had a mean of 14.1 months and the comparison group had a mean of 3.03 months. Experimental group had longer treatment and was longer post injury.</td>
<td>United States</td>
<td>Computer-assisted cognitive rehabilitation program was used in the experimental group. Description of the conventional therapy used in the comparison group was not provided.</td>
<td>The computer-assisted cognitive rehabilitation followed a hierarchical approach by providing training on the basic cognitive processes first prior to addressing the more complex functional skills. The approach was based on Bracy's Process Approach. Four cognitive functioning areas that were remediated through this approach and were measured included attention, visual-spatial abilities, memory, and problem solving. Further detail on the training program was not provided.</td>
<td>Both groups made significant improvement. Gains made in the two groups did not differ based on neuropsychological tests. The experimental group improved in 15 measures while the conventional group improved on 7 measures. Authors suggested that computer-assisted cognitive rehabilitation does not intend to replace a holistic rehabilitation program but that it is one treatment method.</td>
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Rehabilitation of executive dysfunction following brain injury: Content-free cueing improves everyday prospective memory performance.  
*Neuropsychologia, 45*(6), 1318-1330. | Multiple baseline with pre and post measures, n=20.  
- Mixed Traumatic Brain Injury (TBI) and other Acquired Brain Injury (ABI) diagnoses.  
- TBI n=14; median months since injury=27.5; 15 male and 5 female; mean age of 40.8 years. Seven continued to receive other therapy at time of study. | United Kingdom | "Content-free" text messages were used to prompt executive reviews based on Goal Management Training principle. The accuracy of following a schedule to make phone calls was measured in 1 week baseline with no cues, followed by a 2 weeks intervention that involved receiving the content-free text message that says "STOP" on 5 randomly selected days. Comparison was made between days with and without text messages. | Errorless learning was used to teach the schedule of phone calls before the 1-week baseline and after the baseline phase to teach the participants to associate the text message "STOP" to "when I get a text message saying STOP! I should stop what I was doing and think about my current goal." Individual education sessions (30 minutes) were also provided on action slips and prospective memory. Concepts were explained and strategy use illustrated. | Baseline (week 1): 85% call made.  
Treatment Phase (week 2 & 3) - uncued days (71.5%) & cued days (87.6%). Both baseline and cued days were significantly better than the uncued days. Unsure if pre-week outcome was due to novelty or perhaps errorless learning used to train the recall of the schedule. | Not reported. | Not reported. |
### Appendix B: Single-Element Strategy Training Studies (Continued)

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<tr>
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<tr>
<td>Hewitt, J., Evans, J. J., &amp; Dritschel, B. (2006). Theory driven rehabilitation of executive functioning: Improving planning skills in people with traumatic brain injury through the use of an autobiographical episodic memory cueing procedure. <em>Neuropsychologia, 44</em>(8), 1468-1474.</td>
<td>RCT study, n=30. Group 1 (control), n=15 and group 2 (treatment group), n=15.</td>
<td>All participants had severe TBI. Group 1 had mostly males, mean age=33.13 years, and mean time since injury=7 years. Group 2 had mostly males, mean age=38.47 years, and mean time since injury=5.3 years.</td>
<td>United Kingdom</td>
<td>Autobiographical memory retrieval intervention was provided in a 30 minutes individual session. Control group was given a 30 minutes break where they were given a beverage and were engaged in general conversation.</td>
<td>Training involved education on the importance of autobiographical memory to facilitate planning and to apply this strategy on questions that were given. A cue card indicating &quot;Try to think of a specific time and place where you carried out a similar activity in the past&quot; was used during training.</td>
<td>Improvement in effectiveness of plan, number of steps in the plan, and the number of specific memories were found after training. Memory measure correlated with the retrieval of specific memory but not with the effectiveness of plan or number of steps in the plan at post-test compared to pre-test.</td>
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<td>3</td>
<td>Manly, T., Hawkins, K., Evans, J., Woldt, K., &amp; Robertson, I. H. (2002). Rehabilitation of executive function: Facilitation of effective goal management on complex tasks using periodic auditory alerts. <em>Neuropsychologia, 40</em>(3), 271-281.</td>
<td>Pre and post study. Patient group, n=10. Healthy control, n=24. Groups were age, sex and IQ matched.</td>
<td>Patient group had 9 persons with TBI and 9 males. Mean age was 32.1 years and the mean months post injury was 54.5. Healthy control had 18 males and the group's mean age was 29.29 years.</td>
<td>United Kingdom</td>
<td>Two versions of Hotel Task were used and participants were randomly assigned to do one or the other first. The groups were also randomly allotted into half receiving the tone in the first session and half received the tone in the second session. They were given 15 minutes to complete the Hotel Task. The control group was randomly divided into doing either version of the Hotel Task first but no alerting tone was used with this group.</td>
<td>Participants were told that the tone may be useful for them to think of what they were doing and no response was required of them. They were asked to try all 6 activities given in each of the Hotel Task but that they were not expected to complete all 6 activities during the 15 minutes.</td>
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<th>Follow-up Timeframe</th>
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<tr>
<td>Cicerone, K. D., &amp; Giacino, J. T. (1992). Remediation of executive function deficits after traumatic brain injury. <em>Neuro-Rehabilitation</em>, 2, 12-22.</td>
<td>Multiple baseline pre and post study, n=6. Follow-up was completed with 4 participants. One subject was also involved in an ABAB format study on the error-monitoring intervention.</td>
<td>Five individuals had TBI and 1 had ABI (tumour resection). All were males. Their age ranged from 18 to 44 years. They were at least 1 year post TBI.</td>
<td>United States</td>
<td>Self-instructional training was implemented in 10 to 20 hours of individualized sessions over 5 to 9 weeks. A single-case study with an ABAB design was used to evaluate an error-monitoring intervention with one participant who did not appear to have benefited from the self-instructional training. Two participants received additional transfer training, which involved learning how to apply self-instructional training in everyday life.</td>
<td>The Modified Tower of London task was used during evaluation and as the context for self-instructional training. Self-instructional training was delivered in 3 stages: (1) speaking aloud, (2) whispering to self, and (3) speaking silently to oneself. In the ABAB case study, error-monitoring intervention was used. The person was told to stop immediately if an error occurred, he was then directed to the error made, and was required to keep a record of the errors. The person was made to verbalize the error and was guided to rehearse the desired response.</td>
<td>Marked reduction of errors was reported in 5 of 6 participants after training. Behavioural observation showed reduction in off-task behaviour and disinhibited during task performance. One participant did not benefit and authors found this may be related to severe learning and memory deficits. In the case study, error-monitoring intervention led to reduction of errors but errors increased once the intervention was stopped.</td>
<td>Reduction of off-task performance was maintained at follow-up. Follow-up time-frame was not specified.</td>
<td>Decreased disinhibition and impulsiveness or perseverative responses. Only the 2 persons with transfer training showed increased strategy use in untrained tasks.</td>
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<td>Cicerone, K. D., &amp; Wood, J. C.</td>
<td>Single-case study, n=1.</td>
<td>A 20 years old male who sustained a TBI 4 years ago.</td>
<td>United States</td>
<td>Self-instructional training was provided as part of an outpatient rehabilitation program. Attention was addressed first then focus was placed on planning. Two 1-hour sessions per week was completed for 8 weeks. Specific transfer training was implemented in weekly 1-hour sessions for 12 weeks after the self-instructional training.</td>
<td>Self-instructional training was provided in the context of completing the modified Tower of London task. The participant was instructed to follow 3 stages of training: (1) speaking aloud; (2) whispering; and (2) speaking silently to self. General instructions on problem solving were also provided: problem formulation, goal definition, subgoal identification, consideration of alternatives, and self-evaluation. In generalization phase, application of self-instructional strategy outside of sessions to form solutions was stressed. Real life examples were used during training.</td>
<td>Improvement was found in the reduction of incorrect moves and in off-task behaviours during the intervention. Demonstration of planning and use of self-instruction strategy were reported at post-test. Performance on the Tinkertoy test also improved at posttest. Authors suggested that the self-instructional training has positively influenced one's planning ability.</td>
<td>Off-task behaviours and reduction in incorrect moves were maintained at 4-months follow-up.</td>
<td>Self-control ratings improved only with transfer training. Anecdotal reports of strategy use in daily life reported.</td>
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## Appendix C: Multi-Element Strategy Training Studies

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<tr>
<td>Spikman, J. M., Boelen, D. H. E., Lamberts, K. F., Brouwer, W. H., &amp; Fasotti, L. (2010). Effects of a multifaceted treatment program for executive dysfunction after acquired brain injury on indications of executive functioning in daily life. <em>Journal of the International Neuropsychological Society, 16</em>(1), 118-129.</td>
<td>RCT, n=75; 38 in experimental group and 27 in control group. There was also a group of healthy control, n=75.</td>
<td>Mix of Traumatic Brain Injury (TBI) and other Acquired Brain Injury (ABI) diagnoses. No statistically difference was reported between the experimental and the control groups. Mean age=41.4 to 47.8 years. Mean years of education=4.8 to 5.2. Recruited mostly male patients. Mean of 47.9 months post injury in control &amp; 71 months in experimental group.</td>
<td>Netherland</td>
<td>Multifaceted Treatment of Executive Dysfunction (MTED) was based on Goal Management Training and Problem solving Training. It involves 20 to a maximum of 24 individualized 1-hour sessions completed twice a week for 3 months. Control group received computer-based cognitive training. Treatment was given in 7 rehabilitation centres and 2 academic settings. Control group selects 3 goals to work on via computer-based cognitive training.</td>
<td>The MTED involved 3 stages to focus on strategy that forced the participants to explicitly formulate goals or plans, execute the plans, and monitor their behaviours. The 3 stages were: (1) Information and awareness; (2) Goal setting and planning. Three personally relevant goals related to executive function were set; and (3) Initiation, execution and regulation. Worksheets, homework, diary and memory aid were used.</td>
<td>Greater gain in experimental group than in control on goal achievement and role assumptions. Both groups showed improvement in quality of life measure and treatment satisfaction. No change found in neuropsychological measures in either group.</td>
<td>Role assumption and goal achievement showed greater change in experimental than in control group after treatment and at 6-month follow-up.</td>
<td>Illustrated via Role Assumption List and Executive Secretarial Task measures. Transfer and generalization were explicitly trained via exercises and homework.</td>
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<tr>
<td>Toglia, J., Johnston, M. V., Goverover, Y., &amp; Dain, B. (2010). A multi-context approach to promoting transfer of strategy use and self regulation after brain injury: An exploratory study. <em>Brain Injury, 24</em>(4), 664-477.</td>
<td>Single-subject design, n=4. Pre and post study with 4 weeks follow-up. Onset: 3-5 years post TBI. Two male and 2 female with ages 27, 29, 47 and 50 years. All finished high school and 2 had some college education. USA</td>
<td>Multi-context Approach - Nine 75-minutes sessions were provided twice weekly over about 5 weeks. Sessions were held in kitchen, office or nearby community depending on the activity. The first 4 sessions were the same for all participants and the participants choose the activities for the last 5 sessions based on their goals and interests.</td>
<td>Multi-context Approach focuses on practice over gradually modified context, use of everyday activities, and meta-cognitive training to promote self-monitoring and strategy use. Therapist systematically guides strategy generation prior to each activity. All were guided to recognize the need to break the directions into sub-steps or a list. The guidance and intervention were tailored to the individual participant.</td>
<td>Trend towards increased strategy use and awareness based on sub-scales of Self-Regulation Skills Interview. Decrease in errors on the Multiple Errands Task and the Executive Function Performance Test. Less executive dysfunction in daily life for most participants except 1 who had no change. Better ability to specifically identify challenges.</td>
<td>Three persons showed maintenance in majority of the measures at 4 weeks follow-up. One person showed trend towards pre-intervention level in all areas.</td>
<td>Suggested through improvement made in untrained tasks: Multiple Errands Task and Executive Function Performance Test.</td>
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<tr>
<td>Miotto, E. C., Evans, J. J., de Lucia, M. C. S., &amp; Scaff, M. (2009). Rehabilitation of executive dysfunction: A controlled trial of an attention and problem solving treatment group. Neuropsychological Rehabilitation, 19(4), 517-540.</td>
<td>Cross-over design, n=30. Ten persons per group. There were 3 treatment groups: Attention and Problem solving Group Approach (APS), Information Education (IE), and Traditional Rehabilitation (TR) with no cognitive intervention. The IE and TR groups later received APS. Follow-up was completed for all groups at 6-month.</td>
<td>Diagnoses included a mix of TBI and other brain injuries. Pseudo-random allocation into 3 groups (1/2 random assignment and 1/2 matched by age, education, time since injury &amp; performance in baseline neuropsychologic al tests). Mean time post injury=2.4 years; 1:1 male: female ratio; mean age=41.7 years; mean years of education=9.17.</td>
<td>Brazil</td>
<td>APS involved 90 minute weekly group sessions provided over 10 weeks. IE group had to read and do exercises from a booklet. TR involved physiotherapy as needed but did not receive cognitive intervention. Sessions were held in the centre. The APS uses a systematic approach to identify ways to solve problems, manage and monitor goal achievement through mental checking and the use of a goal management routine. Application outside of sessions was encouraged.</td>
<td>Initial focus was on attention and working memory. Then focused on problem solving and using a framework in hypothetical and real life issues from the participants' experiences. Also addressed problem awareness, monitoring and evaluation, and plan formation, initiation and implementation. Framework steps were: identify the goal or task; STOP: THINK; identify and select solution; plan the steps; execute the plan and monitor; and finally evaluate outcome.</td>
<td>No change found in memory, information processing, or executive function. Less executive dysfunction symptoms was reported by the caregivers on Dysexecutive Questionnaire (DEX) with APS but not with IE, TR, or no treatment. No change on DEX self-ratings. Modified Multiple Errands Task (MMET) and Virtual Planning Test outcomes were maintained at 6-month follow-up.</td>
<td>Suggested based on improvement on DEX, MMET, and Virtual Planning Test. Increased full-time and part-time employment reported at follow-up.</td>
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<td>4</td>
<td>Dawson, D. R., Gaya, A., Hunt, A., Levine, B., Lemsky, C., &amp; Polatajko, H. J. (2009). Using the cognitive orientation to occupational performance (CO-OP) with adults with executive dysfunction following traumatic brain injury. <em>Canadian Journal of Occupational Therapy, 76</em>(2), 74-86.</td>
<td>Single-case design with 3-months follow-up, n=3.</td>
<td>Onset: 5, 14 and 17 years post TBI. Ages=32 to 40 years old. Two males and 1 female. Years of education ranged from 13 to 17.</td>
<td>Canada</td>
<td>Cognitive Orientation to daily Occupational Performance (CO-OP) approach was completed in 20 1-hour sessions held twice weekly for 10 weeks at the participants' homes.</td>
<td>The approach teaches the use of a global strategy: goal-plan-do-check. Participants were also guided to develop domain specific strategies during training. Five key elements of the CO-OP approach were identified as: participant's selected goal, dynamic performance analysis, cognitive strategy use, guided discovery, and significant others' involvement.</td>
<td>Most goals were achieved at the end of training. Improvement in untrained goals was reported. Executive dysfunction symptoms decreased based on Dysexecutive Questionnaire (DEX) at post-test.</td>
<td>Goal achievements and DEX scores were mostly maintained at 3-months follow-up. One DEX self-rating showed trend to return to baseline but not in the significant other's rating.</td>
<td>Suggested based on gains in untrained goals.</td>
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### Appendix C: Multi-Element Strategy Training Studies (Continued)

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<tbody>
<tr>
<td>Fong, K. N. K., &amp; Howie, D. R. (2009). Effects of an explicit problem solving skills training program using a metacomponential approach for outpatients with acquired brain injury. <em>American Journal of Occupational Therapy, 63</em>(5), 525-534.</td>
<td>Matched controlled trial with 3-months follow-up. n=33. Experimental group, n=16; comparison group, n=17.</td>
<td>Mixed TBI and other ABI diagnoses. Group assignment was completed by matched pair procedure. Experimental group: 12 males, mean age of 30.6 years, mean years of education=10.5, and mean months post injury=11.8. Comparison group: 15 males, mean age of 34.9 years, mean years of education=10.4 years, and mean months since injury=12. The actual time since injury or its range was not provided, thus minimum time post injury was not available.</td>
<td>Hong Kong</td>
<td>Experimental Treatment involved metacomponential strategies taught through explicit problem solving training in 22 sessions held twice weekly over 15 weeks. Sessions were in groups of 4 to 5 people. If group format could not be tolerated then 1:1 sessions were done. Comparison group had conventional therapy with functional skills training, and cognitive drilling using computer, paper and pencil tasks. Experimental group also had conventional therapy.</td>
<td>Education on a range of metacomponential facets began each experimental session, followed by computer training to practice the skills learned. The metacomponential facets were: everyday attention, information gathering, planning, problem representation, and self-monitoring. Activities used during practice included: define the problem, plan, problem representation, and self-monitoring.</td>
<td>The representation correctness subtest and the total correctness score of the Meta-componential Interview showed significantly greater gains for the experimental group. Real life problem solving showed greater gains with the experimental group but these gains did not reach significance.</td>
<td>Experimental group had poorer scores on Key Search Test and Modified Six Elements Test (MSET) at follow-up. Gains made by the comparison group reached significance at follow-up on the MSET.</td>
<td>Not reported.</td>
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<tr>
<td>Rath, J. F., Simon, D., Langenbahn, D. M., Sherr, R. L., &amp; Diller, L. (2003). Group treatment of problem solving deficits in outpatients with traumatic brain injury: A randomized outcome study. <em>Neuropsychological Rehabilitation, 13</em>(4), 461-488.</td>
<td>Pre and post study with 6-months follow-up. n=60. Participants were randomly assigned into the conventional group, n=28 (19 completed the program), and the innovative group, n=32 (27 completed the program).</td>
<td>All participants had TBI where 23 were male. Mean age was 43.6 years. Mean years of education=15.7. Mean months post injury=48.2.</td>
<td>USA</td>
<td>Innovative group had 24 2-hours long weekly sessions on emotional self-regulation and clear thinking. Conventional group had 24 2-hours weekly sessions on cognitive remediation and psychosocial factors. Five to 8 participants per group. Innovative group had additional 1-hour weekly group sessions. Conventional group had an additional 1-2 hours of individual cognitive remediation session weekly.</td>
<td>Innovative group used a model of cognitive-behavioural problem solving skills: &quot;stop and think&quot; and asking &quot;clear-thinking questions.&quot; Role-play and verbal mediation were used. Pros and cons of the solutions for personally relevant issues were examined. Conventional group applied 5 basic skills including awareness, attention, notetaking, giving and getting feedback, and social skills through paper based exercises and discussions.</td>
<td>Innovative group showed significant gains on measures of problem solving, and problem solving self-appraisal. While conventional group reported less severe somatic symptoms and significant others perceived a decline in cognitive and somatic symptoms.</td>
<td>Maintenance was shown at 6 months.</td>
<td>Not reported.</td>
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</thead>
<tbody>
<tr>
<td>Walker, J. P.</td>
<td>Single-case study with pre and post design, n=1.</td>
<td>33 years old male with Mild TBI; 1-year post injury.</td>
<td>USA</td>
<td>Combination of process-specific and functional approach provided over 4 months. The significant other and the participant developed the intervention program with the therapist. The process-specific approach included learning specific strategies and monitoring performance for executive functions. Functional approach involved the use of strategies in everyday tasks and to self-monitoring performance.</td>
<td>Four step-by-step goals were followed: (1) Promote awareness of cognitive deficits in everyday activities. (2) Develop compensatory strategies for attention, executive dysfunction, working memory, and reasoning. Executive function strategies included plan in advance, organize and analyze the steps, build in flexibility, and self-monitoring. (3) Implement onto activities. (4) Execute multiple difficult activities.</td>
<td>Authors reported gains were maintained and he had returned to work at 1-year post intervention.</td>
<td>Authors reported improved performance in untrained work setting.</td>
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<tr>
<td>Fasotti, L., Kovacs, F., Eling, P. A. T. M., &amp; Brouwer, W. H. (2000). Time pressure management as a compensatory strategy training after closed head injury. <em>Neuropsychological Rehabilitation, 10</em>(1), 47-65.</td>
<td>A randomized pre and post study with 6-months follow-up and control group, n=22. Experimental group had n=12 and control had n=10.</td>
<td>All had sustained TBI at least 3 months prior to the study, with mean months post injury=9.8 for experimental group and 8.3 months for the control group. Experimental group mean age was 26.1 years with a mean of 5.3 years of education. Control group mean age was 30.1 years with a mean of 5.0 years of education. Both groups had mostly males: 8 in experimental group and 7 in control group.</td>
<td>Netherland</td>
<td>Time Pressure Management (TPM) was trained using auditory information recall tasks. Training involved up to 3 1-hour sessions for 2-3 weeks. Control group received concentration training and was taught to follow 4 suggestions to aid recall. Training involved practice of strategies through a story recall task where two forms of stories were played from tapes under increasingly distracting or difficult situations.</td>
<td>TPM training involved education and applying strategy in time pressure situations. The trainer modelled and the trainee instructed self aloud. The strategy, &quot;let me give myself enough time,&quot; had 4 steps: (1) determine if 2 or more tasks were needed to be done at once; (2) make a plan; (3) make an emergency plan in case one feels overwhelmed; and (4) monitor and determine if the plans are ready then implement them. Cue card may be used but were gradually withdrawn.</td>
<td>TPM had a significant effect on the number of steps taken to reduce time pressure. There was no improvement in the use of prevention strategies, and little impact on planning and organization. The difference in task performance between TPM and control did not reach significance although TPM had better performance.</td>
<td>Gains did not drop significantly at follow-up.</td>
<td>No change was found on psycho-social well-being. Improvement in memory and attention tests reported.</td>
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<td>9</td>
<td>Levine, B., Robertson, I. H., Clare, L., Carter, G., Hong, J., Barbara A. Wilson, et al. (2000). Rehabilitation of executive functioning: An experimental-clinical validation of goal management training. <em>Journal of the International Neuropsychological Society</em>, 6, 299-312.</td>
<td>RCT study, n=30, with pre and post measures. There were 2 groups: Goal Management Training (GMT) (n=15) and Motor Skills Training (MST) (n=15). The article also reported on a case study of n=1.</td>
<td>The RCT included individuals with TBI. The Goal Management Training (GMT) group had 5 male, group mean age was 29 years, mean years of education was 12.6, mean years post injury was 3.7 years. The Motor Skills Training (MST) group had 9 male, group mean age was 30.8 years, mean years of education was 13, mean years post injury was 3.8. The case study consisted of one 35-years old female who had a meningo-encephalitis.</td>
<td>Canada. The single case was completed in the United Kingdom.</td>
<td>In the RCT, the GMT and MST sessions were 1 hour long each. Sessions were conducted individually. The MST training involved reading, tracing mirror-reversed text and designs. The case study consisted of 13 sessions where GMT was taught using meal preparation tasks. It began with the GMT training as it was used in the RCT but it was spread over 2 1-hour sessions in the case study.</td>
<td>The GMT, based on Duncan's goal neglect model, has 5 stages: 1. Orienting, 2. Define goal, 3. Forms plans, 4. Learn steps, and 5. Check. The 5 steps were taught using paper and pencil tasks and the participant's examples. The session ended with the application of the strategy onto a real life task.</td>
<td>Reduction in error in grouping task post GMT but not with MST. Increased in error noted in proofreading task post MST and no change post GMT. Error reduction in room layout task reported after either training. Increased time spent on task reported post GMT. Strategy use improved, and errors in Everyday Tasks and problem behaviours decreased post training in the case study.</td>
<td>Not reported in the RCT. Maintenance was reported in the case study at follow-up at 1, 3, and 6 months.</td>
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<tr>
<td>Webb, P. M., &amp; Glueckauf, R. L. (1994). The effects of direct involvement in goal setting on rehabilitation outcome for persons with traumatic brain injuries. <em>Rehabilitation Psychology, 39</em>(3), 179-188.</td>
<td>Pre and post study with 2-months follow-up and control, n=16. Random assignment into 2 groups. All participants had TBI. There were 14 male; 13 live in long-term care and 3 were receiving day treatment. Mean years since injury=8.7. Mean age=27.4 years. Mean years of education=12.1. Two to three individuals were lost at follow-up in each group. <strong>USA</strong> The 2 groups were (1) high involvement goal setting program group and (2) low involvement group. Control group developed goals and wrote them on paper but they did not receive education or goal monitoring training. All participants met with the therapist 1 hour per week for 8 weeks. <strong>High involvement goal setting training program</strong> involved 3 stages: 1. Orientation and education on goal setting, 2. Goal setting and prioritization, and 3. Goal monitoring. Goal monitoring phase was 8 weeks long. Goal review, worksheet, and goal follow-up diary were used as part of goal monitoring process. Both groups made significant gains from pre to post-testing. However, only the individuals in the high involvement goal setting training program made significant gains when comparing pre and follow-up outcomes.</td>
<td>Both groups made significant gains from pre to post-testing. However, only the individuals in the high involvement goal setting training program made significant gains when comparing pre and follow-up outcomes.</td>
<td>Goal achievement was maintained at 2-months follow-up for the high involvement group but not for the low involvement group.</td>
<td>Not reported.</td>
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<tr>
<td>von Cramon, D. Y., Matthes-von Cramon, G., &amp; Mai, N. (1991). Problem solving deficits in brain-injured patients: A therapeutic approach. <em>Neuropsychological Rehabilitation, 1</em>(1), 45-64.</td>
<td>Pre and post study, n=37. They were alternately allotted into 2 groups. Experimental group=problem solving training (PST), n=20. Control group=memory training (MT), n=17.</td>
<td>Among the 37 ABI participants, 18 had TBI. Median age was 44 years; 24 male; median years of education were 11 year; median time since lesion was 7 months.</td>
<td>Germany</td>
<td>Problem solving Training was completed in groups of 3 participants but individual sessions were available if the participant cannot tolerate groups. It consisted of an average of 25 sessions per person implemented over 6 weeks.</td>
<td>PST aimed at guiding the participants to manage multi-steps problems by breaking them into more manageable steps. It targeted 5 aspects of problem solving behaviours: problem orientation, problem definition and formulation, generating alternative, decision-making, and solution verification. Trainer only interfered when needed and provided cues in a graded manner.</td>
<td>Inductive reasoning, categorizing, and similarities in the intelligence subtest, Planning Test, and Tower of Hanoi improved post PST but not after MT. No effect on memory or attention post PST but these did improve post MT. Abnormality in problem solving behaviours decreased post PST but not post MT.</td>
<td>Not reported.</td>
<td>Improved behavioural ratings.</td>
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### Appendix D: Activity-specific Strategy Training Studies

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<tr>
<td>Ownsworth, T., Quinn, H., Fleming, J., Kendall, M., &amp; Shum, D. (2010).</td>
<td>Study 1 - Single-case with ABA design, n=2. Study 2 - Single-case pre &amp; post study, n=1.</td>
<td>Study 1 – Traumatic Brain Injury (TBI), 6 &amp; 7 years post injury, 37 years old male and 43 years old female. Study 2 - TBI, 3 years post injury, 26 years old male.</td>
<td>Australia</td>
<td>McST used non-specific prompts, guided self-regulation responses to checks, and other metacognitive techniques such as role-play, role reversal and audiovisual feedback. Promoted self-evaluation, anticipation, and planning prior to task completion. BP involved therapist providing praises and affirmation of correct performances and gave opportunity for self-error-identification.</td>
<td>Study 1 resulted in increased checks, decreased errors, and increased self-correction. Study 2 did not lead to significant decrease in errors. Authors suggested that BP might result in reliance on external cues and not self-regulation. Both studies resulted in higher ratings of general functional performance. However, MST might result in over-estimation of performance in other tasks. BP might result in more accurate self-appraisal. Authors found this study supports that error self-regulation and self-knowledge are different aspects of meta-cognition.</td>
<td>Gains remained post McST, during the 2nd 4 weeks of BP sessions in study 1. However, no further follow-up reported beyond the ABA study.</td>
<td>Improvement in novel cooking task was reported based on observed low errors, few checks, and high self-corrections post McST. Significant others did not report improvement to other everyday activities</td>
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<tr>
<td>Marshall, R. C., Karow, C. M., Morelli, C. A., Iden, K. K., Dixon, J., &amp; Cranfill, T. B. (2004). Effects of interactive strategy modelling training on problem solving by persons with traumatic brain injury. <em>Aphasiology, 18</em>(8), 659-673.</td>
<td>Pre and post study with 1-month follow-up, n=20.</td>
<td>All participants had TBI. 50% male. Mean years of education=13.16; mean age=35.58 years; mean months post injury=66.</td>
<td>United States</td>
<td>Interactive strategy modelling training (ISMT) was implemented using board games to model strategies and train problem solving skills. Training ends when constraint-seeking questions were asked 80% of the time.</td>
<td>ISMT uses exemplary and strategy modelling through interactive training where the examiner and the participant alternate in taking on the roles of the &quot;problem solver&quot; and the &quot;instructor.&quot;</td>
<td>Improvement was found post-training in the types of questions asked, frequency of guessing, and in Rapid Assessment of problem solving test (RAPS).</td>
<td>Main-tenance was shown at 1-month.</td>
<td>Not reported.</td>
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<tr>
<td>Turkstra, L. S., &amp; Flora, T. L. (2002).</td>
<td>Single-case pre and post design, n=1.</td>
<td>The participant is a 49 years old male with TBI that was sustained 23 years ago. He also had multiple TBI during adolescence.</td>
<td>United States</td>
<td>Treatment consisted of teaching the use of compensatory strategies to address executive dysfunctions to enhance work performance. There were 21 1-hour therapy sessions completed over 10 weeks.</td>
<td>Compensatory strategies focused on disorganization and memory. Sessions consisted of: 5 minutes on spontaneous conversation, 5 minutes on writing, and 50 minute on report-writing. Strategies included using a note-taking format, report writing, and using a report writing computer tool.</td>
<td>Improvement noted in completing organized and structured interviews, and in note taking.</td>
<td>At 10 months, full-time position was secured with support but the first author customized forms and provided further training.</td>
<td>No gains in untrained area of spelling &amp; discourse cohesion. Application of strategies onto new workplace required support. Did not report use of strategies in non-work related activities.</td>
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<tr>
<td>4</td>
<td>Delazer, M., Bodner, T., &amp; Benke, T. (1998). Rehabilitation of arithmetical text problem solving. <em>Neuropsychological Rehabilitation</em>, 8(4), 401-412.</td>
<td>Pre and post study with 10-week follow-up, n=3; healthy control n=5.</td>
<td>All 3 were males with severe TBI, ages were 23, 34 and 30 years. Years post-injury were 1.5 to 2 years. Years of education were 9-12 years. Control was matched by age and education and they were only involved at baseline testing.</td>
<td>Austria</td>
<td>Word problems were given in increasing complexity. Participants would read the problem aloud, answer 3 multiple choice questions related to problem sentences and problem-schema, solve the problem, and create a new problem of a similar style. Training was twice weekly for 8 weeks.</td>
<td>A cuing procedure was used during training to prompt the person to consider the problem sentences and problem-schema. They were asked to only solve the problems after they have answered the 3 prompting questions. Errors were corrected and solutions were discussed between the experimenter and the participant.</td>
<td>Improvement reported in answering complex questions and in the number of correctly applied steps. Encoding errors decreased, but this encoding based training did not affect execution. Execution errors were inconsistent and the number of correct solution did not improve. Impulsiveness decreased for most participants. No significant change in neuropsychological tests except in the WAIS arithmetic subtest.</td>
<td>Improvement in the number of correctly applied steps was maintained at 10 weeks follow-up.</td>
<td>Not reported.</td>
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<tr>
<td>von Cramon, D. Y. &amp; Matthes-von Cramon, G. (1994). Back to work with a chronic dysexecutive syndrome? Neuro-psychological Rehabilitation, 4(4), 399-417.</td>
<td>Single-case design, n=1.</td>
<td>33 years old male medical doctor, 9 years post TBI.</td>
<td>Germany</td>
<td>The approach focused on improving self-observation. Work-related difficulties were addressed by utilizing a problem solving process during treatment. Intervention lasted 12 months and was provided as individual sessions 2 to 3 hours weekly.</td>
<td>Problem solving training involving 3 main steps: (1) problem identification and problem analysis, (2) generation of hypotheses and decision making, and (3) evaluation of solution. Training was applied on specific work-related tasks related to making diagnosis and writing reports. Trainer's fading guidance and self-instruction techniques were used.</td>
<td>Improvement in correct diagnoses and coherence of findings reported. Although he was more attentive to details and used more time to read the information given, he continued to not consider all aspects such as time constraint when completing a task. Over-estimation of own abilities persisted although he agreed some tasks might be difficult in principle.</td>
<td>Not reported.</td>
<td>Application of strategy onto a non-explicitly trained task reported but difficulty with many problem solving tasks continued to be observed post training.</td>
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<tr>
<td>Burke, W. H., Zencius, A. H.,</td>
<td>Multiple baseline case studies.</td>
<td>Subject 1: 38 years old male had TBI (onset time not reported) and was receiving other therapies at time of study. Subject 2: 32 years old male had TBI 8 years ago. Subject 3: 62 years old male had TBI 22 years ago. Subject 4: 28 years old male had TBI 5 yrs ago. Subject 5: 19 years old female with TBI (onset time not reported).</td>
<td>United States</td>
<td>The 3 case studies addressed problem solving, self-initiation, and self-regulation. Case studies 1 and 2 involved strategies training onto work-based activities. Case study 3 focused on behavioural control during interpersonal interaction and exhibitionism. Structure and duration of sessions varied across cases and subjects.</td>
<td>Case study 1 addressed problem solving through 4 tasks (3 trained and 1 untrained). Used checklists, verbal instruction, demonstration, and faded guidance. Case study 2 addressed self-initiation and plan completion. Demonstration, checklists, modelling, and feedback were used. Case study 3 focused on self-regulation. Feedback and recording keeping were used.</td>
<td>Improvement in task performance was reported in all cases based on the behavioural measures used in each case. For study 1, the use of checklist immediately improved.</td>
<td>Maintenance was reported at follow-up where follow-up data was given, including study 1.</td>
<td>Use of strategy in untrained task reported in 1 case study.</td>
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### Appendix E: Scenario-based Problem solving Training Studies

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<tr>
<td>1</td>
<td>Satish, U., Streufert, S., &amp; Eslinger, P. J. (2008). Simulation-based executive cognitive assessment and rehabilitation after traumatic frontal lobe injury: A case report. <em>Disability &amp; Rehabilitation, 30</em>(6), 468-478.</td>
<td>Single-case design, n=1.</td>
<td>47 years old male, 15 months post Traumatic Brain Injury (TBI).</td>
<td>United States</td>
<td>Strategic Management Simulation (SMS), a computer-based evaluation system. Training based on the SMS findings was completed in two phases. Individual sessions were carried out in 1-hour weekly session for 3 months.</td>
<td>Treatment areas were based on assessment findings using the SMS. Phase one involved building understanding and relating everyday work and home experiences with the impaired areas identified on the SMS. The author trained the participant to learn to generate more effective alternative thoughts and actions than the ones he took on the initial simulation test. Phase two involved the participant working on the impaired areas 1 at a time in a progressively difficult order.</td>
<td>Improvements in simulation technology based evaluation reported in &quot;activity&quot;, &quot;initiative&quot;, &quot;information orientation&quot;, &quot;applied emergency response&quot;, &quot;breath of strategic initiative&quot;, and &quot;strategy&quot;. Untrained competency did not change. Self, family's and co-workers' reported functional and behavioural improvement in daily life but this was not formally measured.</td>
<td>Not reported.</td>
<td>Reported to have impacted daily function based on self, family, and co-workers' feedback. Application of learning in day-to-day life was reported.</td>
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## Appendix E: Scenario-based Problem solving Training Studies (Continued)

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<tr>
<td>Man, D. W., Soong, W. Y. L., Tam, S., &amp; Hui-Chan, C. W. Y. (2006a). Development and evaluation of a pictorial-based analogical problem solving programme for people with traumatic brain injury. <em>Brain Injury, 20</em>(9), 981-990.</td>
<td>Pre and post study. Simple random sampling was used to place 30 individuals into the experimental group. Control group, n=20, was matched by age and gender.</td>
<td>All participants had TBI. Treatment group had 18 males and the mean age of 44.87 years. Years since injury=3.48 and 25/30 had at least secondary education. Control group had 13 males and the mean age of 48.55 years. Years since injury=4.13 and 15/20 had at least secondary education.</td>
<td>Hong Kong</td>
<td>Analogical problem solving training approach was implemented over 20 sessions in the experimental group. Control group did not receive experimental treatment and was not receiving other form of cognitive training.</td>
<td>Participants were instructed to draw analogies to solve problems with increasing complexity. Training addressed basic problem solving skills (example: learning about convergent, divergent, comparison and contrast reasoning) to functional problem solving (example: identify cause and effects, and solutions). Homework was given to promote habitualization into daily problem solving. Reflective groups were held between training sessions for peers to share their experiences.</td>
<td>Significant improvement was reported in sequential classification, comparison-contrast, identifying effects and solutions, functional and overall problem solving skills, but not in convergence, divergency and comparison. Within group improvement reported to be significant on the Lawton Instrumental Activity of Daily Living measure.</td>
<td>Not reported.</td>
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<td>Man, D. W. K., Soong, W. Y. L., Tam, S. F., &amp; Hui-Chan, C. W. Y. (2006c). A randomized clinical trial study on the effectiveness of a tele-analogy-based problem solving programme for people with acquired brain injury (ABI). <em>Neuro-Rehabilitation, 21</em>(3), 205-217.</td>
<td>RCT double blinded study, n=109 (103 after drop out). Four study groups: Group 1 (G1)-computer assisted training, n=30 (28 after drop out); group 2 (G2)-therapist-administered cognitive rehabilitation training, n=30; group 3 (G3)-online interactive computer assisted training, n=29 (25 after drop out), and group 4 (G4)-control, n=20.</td>
<td>Mixed TBI and other brain injury diagnoses. Mean ages of each group were G1-42.68, G2-44.87, G3-44.24, and G4-48.55 years. Mean years post injury=G1-3.46, G2-3.48, G3-5.15, and G4-4.13. Participants with at least secondary education = G1-26, G2-25, G3-17, &amp; G4-15. Number of individuals with TBI= G1-4, G2-5, G3-4, and G4-0.</td>
<td>Hong Kong</td>
<td>Analogical problem solving training approach was provided in 3 formats. The control group did not receive any treatment during the 2 months but was offered the opportunity to receive treatment after the study. Each treatment group completed 45-minutes session weekly for 20 weeks. All groups were done at different time so that the participants and the therapists would not become aware of the procedure.</td>
<td>The participants were instructed to draw analogies to solve problems with superficial and / or structural similarities from one problem to the next with increasing difficulty. A self-developed tele-analogy-based problem solving program was used. Trainers used demonstration, role play, positive feedback and errorless learning strategies. All treatment groups had homework. G1 had self-paced computer training and had face-to-face support from the therapist if needed. G2 received face-to-face training. G3 received on-line computer training with the therapist.</td>
<td>Instrumental activities of daily living (IADL) performance and problem solving skills showed within-group improvement but the improvement was comparable between the 3 treatment groups. Only the therapist-led group (G2) showed statistically significant improvement in self-efficacy in the use of problem solving strategies in daily life. Authors concluded that the analogical problem solving training approach was effective regardless of method of delivery.</td>
<td>Not reported.</td>
<td>Indicated improvement in IADL but generalization and transfer were not discussed by authors.</td>
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<td>Soong, W., Tam, S., Man, W., &amp; Hui-Chan, C. (2005). A pilot study on the effectiveness of tele-analogy-based problem solving training for people with brain injuries. International Journal of Rehabilitation Research, 28(4), 341-347.</td>
<td>Pre and post pilot study, n=33 recruited through random sampling. Three treatment groups were formed: group 1 (G1)-computer-assisted training, n=5; group 2 (G2)-online interactive computer-assisted, n=5; and group 3 (G3)-therapist-administered training, n=5.</td>
<td>Participants were reported to have brain injuries (did not specify type). Mean age for G1=38.6 years, G2=35.6 years, and G3=37.4 years. Numbers of participants with at least secondary level of education: G1-80%, G2-60%, and G3-80%. Mean years post-injury were G1-7.12; G2-4.06; and G3-4.8.</td>
<td>Hong Kong</td>
<td>Analogical problem solving training approach was provided in 3 formats. Training consisted of 20 sessions for each group.</td>
<td>G1-participants received training in a self-paced computer-assisted training program with real-time computer feedback. Face-to-face support was provided if needed. G2-participants received online computer training with a remote therapist. The structure of training was the same as in G1. The therapist has full control of the program. G3-therapist provided face-to-face training using content that was the same as in G1 and G2. Homework was completed.</td>
<td>The problem solving approach was reported to be effective in improving problem solving skills and self-efficacy in all 3 groups. Improvement was reported in the Lawton Instrumental Activities of Daily Living and the Halstead-Reitan Test Battery.</td>
<td>Not reported.</td>
<td>Indicated improvement in daily activities but generalization and transfer were not discussed by authors.</td>
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<td>Foxx, R. M., Martella, R. C., &amp; Marchand-Martella, N. E. (1989). The acquisition, maintenance, and generalization of problem solving skills by closed head-injured adults. <em>Behaviour Therapy, 20</em>(1), 61-76.</td>
<td>Pre and post study with control and post-tests at 1, 3 &amp; 6-months control, n=6. Experimental group, n=3, and contrast group, n=3. Study procedure was as follows: Test 1 (4 baseline sessions), probe session 1, 4 Training sessions with cue card, probe session 2, 4 Training sessions without cue card, probe session 3, Test 2 (1 month), Test 3 (3 months), and then Test 4 (6 months).</td>
<td>The contrast group consisted of 2 females and 1 male with a mean age of 28 years and mean years post TBI was 9.3. The experimental group had 3 males with a mean age of 27 years and mean years since TBI was 6.6.</td>
<td>United States</td>
<td>The contrast group did not receive treatment. The experimental group received the problem solving skills training program in a group format (3 persons per group). Training involved 4 sessions on applying the strategy on problems given with the help of a cue card followed by 4 sessions without the use of cue card.</td>
<td>Experimental group: Individuals took turns to give initial and alternative solutions to 48 problem situations. Each participant was exposed to 12 situations per session. The strategy involved answering 4 criterion questions to guide solution formation: 1. When will the problem be solved; 2. Where would you look for help; 3. Who would you talk to; and 4. What would you say? Feedback, coaching, and prompts were used. Scorecards and cash payment were used as feedback. Individual probe sessions were held between training to capture how well the problem solving strategy was used.</td>
<td>Accuracy in answering the criterion questions during training and probe sessions improved from baseline to post-training. Interview and staged interaction improved significantly in the experimental group but not in the contrast group. Authors concluded that the generation of alternative solutions approach is more effective than the single solution approach used in Foxx, et al. (1988).</td>
<td>Maintenance was reported at 6-months post-test interview.</td>
<td>Gains were made in untrained novel situations presented and answered during probe sessions. Anecdotal reports of strategy use in daily life reported in 2 of 3 persons in the experimental group.</td>
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<td>Foxx, R. M., Marchand-Martella, N. E., Martella, R. C., Braunling-McMorrow, D., &amp; et al. (1988). Teaching a problem solving strategy to closed head-injured adults. <em>Behavioural Residential Treatment</em>, 3(3), 193-210.</td>
<td>Pre and post study with control, n=6. 3 in experimental group and 3 in control group. Study procedure involved pre-test, baseline, training with cue card, training without cue card, and then post-test.</td>
<td>The contrast group consisted of 2 males and 1 female, mean age of 28 years and mean years post TBI was 6. The experimental group consisted of 2 females and 1 male, mean age of 23 and mean years post TBI was 5.7.</td>
<td>United States</td>
<td>Problem solving training with and then without cue card was completed with the experimental group. Training with cue card was 3 times per week (35 to 75 minutes each). Sessions continued until at least 90% accuracy was reached. Then followed by 4 training sessions without cue card. Training was completed in a group format with 3 subjects and 1 trainer. The contrast group only completed pre and post assessment.</td>
<td>Group participant provided one solution for the 32 situations during each training session. Five criterion questions were used for scoring, providing feedback, and as cues during training. The trainer modelled, provided feedback, prompted, and coached the participants to provide a correct solution if 1 or more of their answer to the criterion questions was incorrect or missing. Scorecards and cash payments were used as feedback. The 5 criterion questions: 1. Restate the problem, questions 2 to 5 were the same as the 4 questions used in Foxx, et al. (1989) study.</td>
<td>Greater gains were reported for the experimental group at post-test in their performances in phone calls, interviews, staged interactions, and test criterion components. Repetition of the situations across sessions led to participants' report of becoming bored and inattentive.</td>
<td>Not reported.</td>
<td>There were anecdotic patients' reports in their application of learning onto everyday life situations.</td>
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<td>Bombardier, Bell, Temkin, Fann, Hoffman, &amp; Dikmen (2009). The efficacy of a scheduled telephone intervention for ameliorating depressive symptoms during the first year after traumatic brain injury. <em>Journal of Head Trauma Rehabilitation</em>, 24(4), 230-238.</td>
<td>United States</td>
<td>n=126 randomized into treatment and no treatment groups. All had traumatic brain injury (TBI). Mean age was 36 years and 75% were male. Participants scored within normal range on the depression scale at baseline but control group had significantly greater depressive symptoms than treatment group.</td>
<td>Randomized control study with 12-months follow-up. Control group did not receive treatment but was involved in evaluation. Technology Used: Telephone</td>
<td>Telephone intervention was provided at 2 weeks, 4 weeks, 2, 3, 5, 7, &amp; 9 months following inpatient stay. Introductory letter, study information, and in some cases, resources were sent by mail to the participants. Phone calls were 30-45 minutes long and had 3 elements: follow-up on previous concerns, identify and prioritize the current concerns. Participants were given information, mentored, assisted to set goals, plans &amp; model problem solving. Referral may be made to other resources. Motivational interviewing counselling style was used.</td>
<td>At 1 year, control had greater increase in depressive symptoms than treatment group. The difference remained significant when baseline scores were adjusted. Depression symptom severity favoured the treatment group. Depression scores did not vary depending on age, sex and coma severity. But greater depression found in non-white participants than in white participants. Authors found telephone intervention helped to prevent depression post TBI.</td>
<td>Depression symptoms less in treatment group at 1-year follow-up.</td>
<td>Not reported.</td>
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Appendix F: Tele-Rehabilitation Intervention Studies with Adults with Traumatic Brain Injury (Continued)

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<td>Bergquist, T., Gehl, C., Mandrekar, J., Lepore, S., Hanna, S., Osten, A., et al. (2009). The effect of internet-based cognitive rehabilitation in persons with memory impairments after severe traumatic brain injury. <em>Brain Injury, 23</em>(10), 790-799.</td>
<td>United States</td>
<td>n=18 (14 completed the study). Mean age=48 years. Mostly males. All had at least high school diploma. All had TBI.</td>
<td>Cross-over design. All received instant messaging training then randomized into 2 intervention groups: calendar (treatment group) &amp; diary (control condition). Both groups had 2-3 sessions per week with a total of 30 sessions for each intervention. The groups switched their intervention when the initial intervention was completed. Assessment was done before, between the 2 interventions, and after the final intervention. Technology Used: Instant Messaging via Computer</td>
<td>Initial instant messaging on-site trainings was 2 hours long. The participants were given a program &amp; were taught to install it at home. Everyone was given a calendar with the first on-line session marked. Family was told not to remind the participants of the appointment schedule. Intervention group: participants logged onto the system to learn calendar use with therapist. They were also encouraged to identify ways to use this in daily life. Control group: participants recorded their daily events in the diary.</td>
<td>No difference found between the 2 groups. Both improved. Calendar group was found to have significant functional improvement. Caregivers, but not patients, reported better mood &amp; fewer memory problems post intervention. Increased use of compensatory strategies was noted post training. Of those who completed the study, 64% have used a planner or calendar at least once a day &amp; only 17% who did not complete the study have used a planner or calendar prior to the study.</td>
<td>Not reported.</td>
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<td>Bradbury, Cheryl L. Christensen, Bruce K., Lau, M. A., Ruttan, L. A., Arundine, A. L., &amp; Green, R. E. (2008). The efficacy of cognitive behaviour therapy in the treatment of emotional distress after acquired brain injury. <em>Archive of Physical Medicine and Rehabilitation, 89</em>(12 Suppl), 561-568.</td>
<td>Canada</td>
<td>n=20. Cognitive Behavioural Therapy (n=10), mean age=39.8 years, 50% male, mean years post injury=7. Education control (n=10), mean age=42.5 years, 50% male, mean year post injury=11.4. A mix of TBI and non-TBI diagnoses.</td>
<td>Matched controlled trial with pre &amp; post measures, and 1-month follow-up. The 2 matched groups were: Cognitive Behavioural Therapy (CBT) &amp; Education Control. Half of each group was assigned to telephone &amp; half to conventional group format; assignment was done based on logistical considerations (transportation). Control received general education on the brain and was told the trainer was not there to provide counselling. Technology Used: Telephone</td>
<td>The 11 sessions of CBT consisted of 1 introductory individual session and 10 face-to-face group or 10 individual telephone sessions. Sessions were once or twice per week and were all completed within 9 weeks. Each session range from 45 to 75 minutes long.</td>
<td>Distress and improvement in emotional disturbance improved significantly to within normative range at post-test (it was at moderate range during pre-test). CBT in either formats had significant treatment effects. There was no significance between-group difference at post-test when comparing the 2 delivery formats of CBT. No significant improvement found after receiving either format of education.</td>
<td>CBT showed greater improvement in function &amp; reduction in distress from pre to follow-up than in control group. There were no change when compared post and follow-up data, showing maintenance of treatment effect.</td>
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<td>Bell, K. R., Hoffman, J. M., Temkin, N. R., Powell, J. M., Fraser, R. T., Esselman, P. C., et al. (2008). The effect of telephone counselling on reducing post-traumatic symptoms after mild traumatic brain injury: A randomised trial. <em>Journal of Neurology, Neurosurgery &amp; Psychiatry</em>, 79(11), 1275-1281.</td>
<td>United States</td>
<td>n=312. Treatment group: mean age=33 years, 66% male, most completed at least high school. Control: mean age=32 years, 64% male, most finished at least high school. All with Mild TBI &amp; were recently injured.</td>
<td>Randomized study with control, included baseline &amp; 6-months evaluation. Control received usual care, patient instruction handout, and assigned outpatient treatment. Baseline assessments were done at the hospital. Outcome was measured at 6-months over the telephone.</td>
<td>Treatment group received 4 to 5 phone sessions, focusing on education, symptom management, and everyday activities resumption. Patient instruction handout, wallet card with the study’s toll-free content number, brain injury handbook, and usual treatment were provided. Calls were made at 2 days, then at 2, 4, 8, and 12 weeks post injury. Trainers were trained on motivational interviewing and self-management techniques. Calls involved review of issues, identify new issues, model problem solving, and provide encouragement.</td>
<td>Telephone group had significantly fewer symptoms and less impact of symptoms on daily activities at 6 months but no effect on the general health composite. Males appeared to benefit more. Authors suggested telephone counselling with a focus on symptom management and encouragement to return to everyday activities was successful in reducing development of chronic symptoms after mild TBI.</td>
<td>Fewer symptoms at 6 months.</td>
<td>Not reported.</td>
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<td>McGrath, N., Jr., M. M. D., &amp; Goldstein, R. (2008). Clinical supervision of a client with traumatic brain injury in a host home placement using video teleconferencing: A case study. <em>Journal of Head Trauma Rehabilitation</em>, 23(6), 388-393.</td>
<td>USA</td>
<td>n=1, 41 year old male, 3 years post severe TBI.</td>
<td>A single case study with an ABA design. Treatment was provided over a 12-weeks duration. Video-conferences were used and each session ranged from 30 to 45 minutes long. The aim of the study was to compare video-conference with the weekly face-to-face visits completed by the clinical case coordinator. The intervention began &amp; ended with 4 weeks of regular interaction that involved weekly in-home visits and phone calls. Technology Used: Video-conference via computer.</td>
<td>The intervention involved 4 weeks of weekly video-conferencing between the clinical case coordinator at the office and the client &amp; the mentor who were in the home. Phone calls between &quot;visits&quot; continued to occur. The study used commercially available personal computer, webcam &amp; Internet networks at the participant's home.</td>
<td>Weekly ratings were taken from the client, the mentor, &amp; the clinical case coordinator using a structured survey. Debriefing interview was done post intervention. Client &amp; case coordinator's ratings did not show significant differences on any measures when receiving either format of visits. The client was not comfortable having a computer and a web-cam at home, felt self-conscious and reported the videoconferencing did not allow him to show the workers things around the home. Video-conferencing was not superior to face-to-face but may supplement in-person sessions.</td>
<td>Not reported.</td>
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<td>Huijgen, B. C. H., Vollenbroek-Hutten, M. M. R., Zampolini, M., Opisso, E., Bernabeu, M., Van Nieuwenhoven, J., et al. (2008). Feasibility of a home-based telerehabilitation system compared to usual care: Arm/hand function in patients with stroke, traumatic brain injury and multiple sclerosis. <em>Journal of Telemedicine and Telecare, 14</em>(5), 249-256.</td>
<td>Italy, Spain &amp; Belgium.</td>
<td>Participants either had Multiple Sclerosis, Stroke, or TBI. n=81 (26 control, 55 treatment). Intervention group: average age of 47 years, 39 male, 9.7 years post onset, 20 TBI. Control group: average age of 50 years, 18 male, average 10.2 years post onset, 10 TBI. No significant difference found at baseline between groups.</td>
<td>Feasibility study. Multi centres RCT. Compared Home Care Activity Desk telerehabilitation system with usual care of general exercise group provided 3 times per week for about 45 minutes per session. The control group received 1 month of usual care. The intervention group received 1 month of usual care then 4 training sessions on the system, followed by 1 month of telerehabilitation training received at least once per day for 5 days per week with an average duration of 30 minutes. Technology Used: Video-conference and computer-based training system</td>
<td>The Home Care Activity Desk telerehabilitation system composed of hospital-based server and portable unit that were installed in the participant's home. Video-conferencing and recording capability were present and the therapist used recorded information during their weekly video-conference with the participant.</td>
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<td>Hermens, H., Huijgen, B., Giacomozzi, C., Ilsbroukx, S., Macellari, V., Prats, E., et al. (2008). Clinical assessment of the HELLODOC tele-rehabilitation service. <em>Annali Dell'Istituto Superiore Di Sanita, 44</em>(2), 154-163.</td>
<td>Italy, Spain &amp; Belgium.</td>
<td>Participants either had Multiple Sclerosis, Stroke, or TBI. n=81 (26 control, 55 treatment). Intervention group: average age of 47 years, with 20 TBI. Control group: average age of 50 years, with 10 TBI. No significant difference found at baseline between groups.</td>
<td>RCT and patient-control design. Four assessment phases’ outcomes reported. Control group: usual care with prescribed exercises. Technology Used: Video-conference and computer-based training system</td>
<td>The Home Care Activity Desk tele-rehabilitation system composed of hospital-based server and portable unit that were installed in the participant's home. Intervention group: 1 month of usual care, then 4 training sessions with the Home Care Activity Desk in the hospital, followed by training at home using the prescribed system for 1-month (average of one at-least 30 minutes session per day for 5 days per week). The participants had weekly videoconference with the therapist. Subjects then continue usual care at home after the intervention was completed.</td>
<td>Changes at the test phases were not significant concluding that arm/hand function remained at the same level in both groups. Authors found tele-rehabilitation program more consistent and efficient than usual care. Increased use of the tele-rehabilitation system showed trend of higher post-intervention scores in participants, but further research is needed to examine if longer treatment duration will lead to greater benefit. Patients and therapists' satisfaction were both high.</td>
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<td>Bergquist, T., Gehl, C., Lepore, S., Holzworth, N., &amp; Beaulieu, W. (2008). Internet-based cognitive rehabilitation in individuals with acquired brain injury: A pilot feasibility study. <em>Brain Injury</em>, 22(11), 891-897.</td>
<td>United States</td>
<td>n=10, 5 males &amp; 5 females. Average age of 45.5 years, 14.7 years of education and 7.4 years post onset. All participants have used a computer &amp; Internet before. Some (30%) have used a calendar at least once per day &amp; checked things off prior to the study.</td>
<td>Pre &amp; post study. Therapy sessions ranged from 12 to 62 sessions, with an average of 32 sessions. Technology Used: Instant Messaging via Computer</td>
<td>All participants received on-site instant messaging system training. Participants logged onto the system from home to receive the actual intervention. Therapy focused on developing calendar skills to address everyday issues related to memory problems. A 3-steps calendar approach was used: acquisition, application, &amp; adaptation phase. Eight questions were used at each phase to assess the participant's skills. Accurate answers in 3 consecutive sessions prompt progression to the next phase and ends at the final phase. The family was told not to remind the participants of their appointments.</td>
<td>There was a 4% overall &quot;no show rate,&quot; and 2 of 10 participants had missed sessions (1 session &amp; 3 sessions). Outcome indicated persons with memory impairment after ABI can independently log in. Participants were also able to use or follow the calendar approach using instant messaging. Authors concluded that the system appeared to be feasible &amp; a larger study was needed.</td>
<td>Not reported.</td>
<td>Not reported.</td>
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### Appendix F: Tele-Rehabilitation Intervention Studies with Adults with Traumatic Brain Injury (Continued)

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<tr>
<td>Bourgeois, M. S., Lenius, K., Turkstra, L., &amp; Camp, C. (2007). The effects of cognitive teletherapy on reported everyday memory behaviours of persons with chronic traumatic brain injury. <em>Brain Injury, 21</em>(12), 1245-1257.</td>
<td>United States</td>
<td>n=38 completed the program (51 started initially). Treatment group: mean age 43, years post injury=9.68, 14 male, n=22. Control group: mean age 40, years post injury =12.94, 10 male, n=16.</td>
<td>Quasi-randomized design. Pre, post &amp; follow-up at 1 week &amp; 1 month post intervention. Stratified pairing based on age &amp; sex used to assign participants into groups. The two groups received either spaced retrieval training or didactic strategy instruction. Control group received the same number of hours of treatment that involved education on memory strategies. Technology Used: Telephone</td>
<td>The treatment group first identified 3 goals based on their problems. Memory log forms were given to track occurrence of the problems in the baseline week. Treatment included 35 minutes telephone sessions that were scheduled 4 or 5 days per week. The trainer established a prompt question and answer for the goals that were set. Participants were trained to state the answer when the question was asked. Errorless learning and spaced retrieval training were used. Completion was based on correct response in 3 consecutive sessions. Sessions ended when 3 goals were completed.</td>
<td>Mastery achieved in an average of 11.8 sessions for the spaced retrieval group. Higher goal mastery in spaced retrieval training than in didactic strategy training was reported; treatment group had on average 2.5 goals that had correct response while average for the control group was 1.2 goals after training. The frequency of memory problems reduced in both groups based on memory logs and was maintained. No significant change in community integration and quality of life measures or generalization of strategy use.</td>
<td>Follow-up at 1-month showed correct response on 2.8 goals in treatment group and 0.85 goals in control group. Caregivers reported demonstration of strategy use was noted in 1.74 goals in daily life for treatment group &amp; 0.84 goals in control group.</td>
<td>No significant impact on community integration was found.</td>
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### Appendix F: Tele-Rehabilitation Intervention Studies with Adults with Traumatic Brain Injury (Continued)

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<td>10</td>
<td>Man, D. W. K., Soong, W. Y. L., Tam, S. F., &amp; Hui-Chan, C. W. Y. (2006b). Self-efficacy outcomes of people with brain injury in cognitive skill training using different types of trainer-trainee interaction. <em>Brain Injury, 20</em>(9), 959-970.</td>
<td>Hong Kong</td>
<td>n=103, &amp; 83 completed the programs. Computer group (G1) n=28, therapist-assisted group (G2) n=30, and online group (G3) n=25. Mean ages of each groups were G1: 42.68, G2: 44.87, G3: 44.24. Mean years post injury of all subjects was 3.98 years.</td>
<td>Pre &amp; post randomized trail. There were 3 groups: direct trainer-trainee, self-paced computer-assisted, &amp; on-line training. Technology Used: Computer Program with video-conference capacity</td>
<td>G1 received self-paced computer training with face-to-face support from the therapist if needed. G2-therapists administrated the same content as in group 1 but in a face-to-face format. G3-involved on-line administration of the same program used in the computer-assisted group. The therapist shared the screen with the trainee, had full control of the program, and they can demonstrate strategies and provide feedback during the training. Homework consisted of 10 problem scenarios that corresponded to the objectives of the sessions.</td>
<td>The study found that analogical problem solving skill training was effective regardless of the mode of delivery. No significant difference in problem solving skills was found between groups. However, only face-to-face format showed significant improvement in their problem solving self-efficacy. The other 2 groups showed improved self-efficacy but these changes did not reach significance. Only the computer-assisted group, which had the least therapist interaction, showed significant correlation between pre-training self-efficacy level and outcome.</td>
<td>Not reported.</td>
<td>Not discussed but indicated improvement in daily activities post training.</td>
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<td>Man, D. W. K., Soong, W. Y. L., Tam, S. F., &amp; Hui-Chan, C. W. Y. (2006c)</td>
<td>Hong Kong</td>
<td>RCT double blinded study, n=109 (103 after drop out). Mixed TBI and other brain injury diagnoses. Four groups: group 1 (G1)-computer assisted training, n=30 (28 after drop out); group 2 (G2)-therapist-administered cognitive training, n=30; group 3 (G3)-online computer assisted training, n=29 (25 after drop out), and group 4 (G4)-control, n=20. Mean ages were G1-42.68, G2-44.87, G3-44.24, and G4-48.55 years. Mean years post injury were G1-3.46, G2-3.48, G3-5.15, and G4-4.13.</td>
<td>RCT with pre &amp; post measures. Analogue problem solving training approach was provided in 3 formats. Each treatment group completed a 45-minutes session weekly for 20 weeks. The control group did not receive any treatment during the 2 months of the study but was offered the opportunity to receive the treatment after the study. Technology Used: Computer Program with video-conference capacity</td>
<td>The participants were instructed to draw analogies to solve problems with superficial and / or structural similarities from one problem to the next in progressing difficulty. A self-developed tele-analogy-based problem solving program was used. During the training, the therapist would demonstrate the analogy problem solving training to the trainees. Role play, positive feedback, and errorless learning strategies were used. All treatment groups had homework/ exercises. G1-self-paced computer program with face-to-face support if needed. G2-therapists administrated. G3-Online administration with the therapist.</td>
<td>Not reported.</td>
<td>Not discussed but reported improvement in IADL post training.</td>
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<td>Bell, K. R., Temkin, N. R., Esselman, P. C., Doctor, J. N., Bombardier, C. H., Fraser, R. T., et al. (2005). The effect of a scheduled telephone intervention on outcome after moderate to severe traumatic brain injury: A randomized trial. <em>Archive of Physical Medicine and Rehabilitation</em>, 86(5), 851-856.</td>
<td>United States</td>
<td>Started with n=171, but 157 completed the study.</td>
<td>Randomized study with control. Control did not receive any contact until 1-year later for follow-up interview. All participants were encouraged to follow discharge recommendations including additional therapy at discharge. Technology Used: Telephone</td>
<td>The intervention group received telephone calls made within 2 weeks from discharge from the inpatient rehabilitation, and then at 4 weeks, 2, 3, 5, 7 &amp; 9 months. Information was sent by mail. The telephone sessions were 30 to 45 minutes in length and they involved 3 elements: (1) follow-up on previously identified issues, (2) identify current concerns, and (3) determine level of intervention regarding concerns. The clinician may provide information, mentor, guide problem solving, and / or make referrals to resources. Motivational interviewing principles were used.</td>
<td>Telephone follow-up group had significantly better functional status and perceived quality of well-being. When race was considered, better outcome was found in usual care group for nonwhites &amp; Hispanics participants. Authors concluded that telephone counselling was effective in enhancing overall function and quality of life at 1-year but modifications may be needed for different ethnic groups.</td>
<td>Not reported.</td>
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### Appendix F: Tele-Rehabilitation Intervention Studies with Adults with Traumatic Brain Injury (Continued)

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<tr>
<td>Melton, A. K., &amp; Bourgeois, M. S. (2005). Training compensatory memory strategies via the telephone for persons with TBI. <em>Aphasiology, 19</em>(3-5), 353-364.</td>
<td>United States</td>
<td>n=7, 3 males, age ranged from 33 to 56 years. Time since injury was 2 to 30 years. All participants have received cognitive training but not during the time of the intervention. All have used some external aid but all reported they were dissatisfied with their systems.</td>
<td>Pre &amp; post study with follow-up at 1-month. Technology Used: Telephone</td>
<td>Participants identified 3 goals for training. Spaced retrieval training began in the clinic for goal one. The goals (or problems) and solutions are structured into questions &amp; answers. Through errorless learning &amp; spaced retrieval, the participants were trained to state the solutions when the questions were asked. One goal was trained at one time. A progressively longer gap between retrieval occurs as participant improves. Daily telephone training sessions lasted a maximum of 30 minutes. Three consecutively successful sessions would indicate completion. Sessions continued until all 3 goals were mastered.</td>
<td>There were 20 or 21 goals that were mastered in 5.3 sessions. There were a mean of 2.3 missed-calls.</td>
<td>Not reported.</td>
<td>16 of 21 goals were followed through outside of sessions. Strategy use onto unrelated tasks was reported by 5 of 7 participants.</td>
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<tr>
<td>Turkstra, L. S., &amp; Bourgeois, M. (2005). Intervention for a modern day HM: Errorless learning of practical goals. <em>Journal of Medical Speech-Language Pathology, 13</em>(3), 205-212.</td>
<td>United States</td>
<td>n=1. Age unclear but has college-age daughter and required 24 hours supervision at time of intervention. TBI was sustained in 1997.</td>
<td>Case study with one-week behaviour tracking at baseline and at 1-month post intervention. Measures included behavioural logs and questionnaires. Technology Used: Telephone</td>
<td>Spaced Retrieval training. Involved identification of 3 goals. Wording of the goals was refined to formulate questions &amp; responses to be used during training. Daily 30-minutes treatment on phone was done until mastery was observed. Mastery was indicated when the participant can state the correct response for the target goal at the beginning of 3 consecutive days</td>
<td>He reached the goal of stating the correct response but did not transfer the goals to activities of everyday living. Goals were stated as words and not action, &amp; changes in caregivers may have led to inconsistency during implementation. Continual Spaced Retrieval training continued post training and subsequent goals were more action focused and caregiver training was emphasized after the study for several months. Improvement and increased independence were reported at 4 months.</td>
<td>Continual training was done after the study and authors reported continual gains at 4 months.</td>
<td>At post-intervention, performance did not carry over into everyday tasks.</td>
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<tr>
<td>Soong, W., Tam, S., Man, W., &amp; Hui-Chan, C. (2005)</td>
<td>Hong Kong</td>
<td>n=33 recruited via random sampling. The 3 treatment groups were: Group 1- computer-assisted training, n=5, mean age 38.6 years; Group 2-online interactive computer-assisted, n=5, mean age of 35.6 years; and Group 3-therapist-administered training, n=5, mean age of 37.4 years. Participants were reported to have brain injuries (did not specify type). Most had at least secondary level of education. Mean years post-injury were Group 1-7.12; Group 2-4.06; and Group3-4.8.</td>
<td>Pre and post pilot study. Analogical problem solving training approach was provided in 3 formats. Training consisted of 20 sessions for each group. Technology Used: Computer Program with video-conference capacity</td>
<td>Analogical problem solving training was provided in 3 formats: Group 1-participant received training in a self-paced computer-assisted training program with real-time computer feedback. Face-to-face support was provided if needed. Group 2-participants received online training with a remote therapist. The structure of training was the same as in Group 1. The therapist has full control of the program during administration. Group 3-therapist provided face-to-face training using content that was the same as in Group 1 and Group 2. Homework was completed in all 3 groups.</td>
<td>Not reported.</td>
<td>Not discussed but reported improvement in IADL post training.</td>
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<tr>
<td>Bell, K. R., Hoffman, J. M., Doctor, J. N., Powell, J. M., Esselman, P., Bombardier, C., et al. (2004).</td>
<td>United States</td>
<td>n=84. Mean age=34.4 years, had mostly males, and most had at least high school education.</td>
<td>Telephone session occurred at 2 weeks post discharge, and then at 4 weeks, and 2, 3, 5, 7, &amp; 9 months. Technology Used: Telephone</td>
<td>The telephone sessions were 30 to 45 minutes long and their times were prescheduled. A toll-free number was also given to the participants if they have questions or needed assistance. A password protected website and manual were also used. 4 levels of interventions were provided: level 1 were ones that were completed during the calls; level 2 involved referral to community resources; level 3 involved triage to a regional or tertiary centre; and level 4 involved emergency assistance.</td>
<td>The top 5 most frequent problems were medical (17%), work-related (11%), cognitive-behavioural (9%), financial (8%), and emotional difficulties (8%). Significant others' top 6 frequent problems were medical (13%), cognitive-behavioural 10%, financial (9%), caregiver stress (8%), emotional (7%), and alcohol-related (7%). Most (84%) intervention was level 1. About 53% did require some level of intervention. Calls were 2 to 176 minutes. More reported issues on the phone than on the rehabilitation physicians' notes.</td>
<td>Not reported.</td>
<td>Not reported.</td>
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<td>Tam, S., Man, W. K., Hui-Chan, C. W. Y., Lau, A., Yip, B., &amp; Cheung, W. (2003)</td>
<td>Hong Kong</td>
<td>n=3. Participant 1 (P1) was 37 years old with TBI. Participant 2 (P2) was 20 years old university student with TBI. Participant 3 (P3) was a 20 years old female with arterioventricular malformation that has led to a haemorrhage.</td>
<td>ABA reversal single case design. Technology Used: Computer Program</td>
<td>P1-tailor made treatment program to address word recognition; application onto a game was done when recognition of words was demonstrated. P2-tailor made treatment to include games for motivation, focused on prospective memory, practiced delayed recall with interruption. P3-focused on memory where she was asked to remember related &amp; unrelated information as practice. Memory strategies were taught &amp; trained.</td>
<td>P1-improve during treatment but declined with withdrawal. Subject reported an increase in confidence post training. P2-improvement during treatment but declined with withdrawal. P3-improvement during treatment and declined with withdrawal. Tailor-made assessments based on problems identified were also used as outcome measures.</td>
<td>Not reported.</td>
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<tr>
<td>Warden, D. L., Salazar, A. M., Martin, E. M., Schwab, K. A., Coyle, M., &amp; Walter, J. (2000). A home program of rehabilitation for moderately severe traumatic brain injury patients. <em>Journal of Head Trauma Rehabilitation, 15</em>(5), 1092-1102.</td>
<td>United States</td>
<td>n=53 were randomized into home program &amp; were followed for 1 year. All had TBI.</td>
<td>Part of an RCT study (Salazar, et al, 2000). Only the experimental group was reported in this paper. Technology Used: Telephone</td>
<td>A master’s level psychiatric nurse made weekly phone calls to participants. The program began with 5 days of multidisciplinary on-site evaluation and a planning meeting with the nurse. Calls were used to develop therapeutic alliance, foster self-direction, support coping in the adjustment to TBI, and assist patient and family in problem solving. Calls were made to the patients but the family caregivers were welcomed to speak with the nurse. Nurse had a checklist of areas to assess at each call. Weekly multidisciplinary meetings with the study physician was done by the nurse and referrals to other resources were made as needed.</td>
<td>No statistically significant difference in return to work &amp; fitness for duty at 1 year between inpatient &amp; home program</td>
<td>No statistically significant difference in return to work &amp; fitness for duty at 1 year between inpatient &amp; home program</td>
<td>Not discussed</td>
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<tr>
<td>19 Salazar, A. M., Warden, D. L., Schwab, K., Spector, J., Braverman, S., Walter, J., et al. (2000). Cognitive rehabilitation for traumatic brain injury: A randomized trial. Journal of American Medical Association, 283(23), 3075-3081.</td>
<td>United States</td>
<td>Hospital group, n=67. In-home program, n=53. All had TBI but patients with mild TBI were excluded. There were no significant differences between the groups in age, sex, military rank, education, race, and type or severity of injury.</td>
<td>RCT. Compared in-hospital rehabilitation program with home program. The hospital-based program was a multi-disciplinary inpatient program that provided physical, cognitive, psychotherapy, community re-entry, and return-to-work training. Technology Used: Telephone</td>
<td>Home program received education and consult during a weekly 30-minutes telephone call with a nurse. At 2 months, 76% received at least 30 minutes of call per day. The participants were given educational materials and recommendation on strategies for cognitive and organization skills. The participants also resumed physical activities at their own pace.</td>
<td>There was no significant difference in return to work or fitness for duty, or quality of life at 1 year between the 2 groups. Most reported cognitive improvement but increased verbal aggression at 1 year. There is a trend toward higher benefit for in-hospital program for individuals with more severe TBI and/or unconscious for more than 1 hour. Individuals benefited more in the home program if they were unconscious for 1 hour or less post TBI. Authors suggested ongoing support in light of increased aggression reported at 1-year follow-up.</td>
<td>No statistically significant difference in return to work &amp; fitness for duty at 1 year between inpatient &amp; home program</td>
<td>Not discussed</td>
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### Appendix G: Participants' Goals and Performance Ratings

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<th>Self - Performance</th>
<th>Significant Other - Performance</th>
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<td>Pre</td>
<td>Post</td>
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<tr>
<td>Participant 1</td>
<td></td>
<td></td>
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<tr>
<td>4. Be more mobile</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>5. To better organize my day</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>6. Find leisure activity to do</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Participant 2</td>
<td></td>
<td></td>
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<tr>
<td>1. Dress myself</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>2. Use the toilet by myself</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>3. Get off the chair with no assistance</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>Participant 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Find paid work</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>2. Take a certificate course</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>3. Take care of myself through exercise and relaxation</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>4. Complete insurance and benefit paperwork for self and family</td>
<td>9</td>
<td>1</td>
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**Untrained Goals Set at Pre-Intervention**

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<th>Self - Performance</th>
<th>Significant Other - Performance</th>
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<tr>
<td></td>
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<td>Post</td>
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<tr>
<td>Participant 1</td>
<td></td>
<td></td>
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<tr>
<td>1. To exercise and walk at the gym twice a week</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>2. No fall in one week</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Participant 2</td>
<td></td>
<td></td>
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<tr>
<td>5. Sleep through the night</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>6. Help my daughter</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>7. Walk alone without the cane</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>8. Get snack and transport it while walking alone</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>Participant 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Cook for my wife</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>2. Sleep better</td>
<td>6</td>
<td>4</td>
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**Untrained Goals Set at Post-Intervention**

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<tr>
<td>Participant 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Do laundry by myself</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>2. Do grocery shopping by myself</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>3. To fit things into my schedule</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>Participant 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Type 100 words per minute on the keyboard</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>2. Find computer-related paid work</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>3. Take a course</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Participant 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Quit smoking</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>5. Complete a volunteer work project</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>6. Prepare photos to sell</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

*I=Importance rating; F-Up=Follow-Up; N/A and shaded areas=ratings not available.

*All rating scales are from 1 to 10 (1=the least, 10=the most). A change of 2 is considered clinically significant (Law et al., 1998).*
Appendix H: Participants' Goals and Satisfaction Ratings

<table>
<thead>
<tr>
<th>Trained Goals</th>
<th>Self - Satisfaction</th>
<th>Significant Other - Satisfaction</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>Participant 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Be more mobile</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>2. To better organize my day</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>3. Find leisure activity to do</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Participant 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Dress myself</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>2. Use the toilet by myself</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>3. Get off the chair with no assistance</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>Participant 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Find paid work</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>2. Take a certificate course</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>3. Take care of myself through</td>
<td>5</td>
<td>3</td>
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<tr>
<td>exercise and relaxation</td>
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<td></td>
</tr>
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<td>4. Complete insurance and benefit</td>
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<tr>
<td>paperwork for self and family</td>
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Untrained Goals Set at Pre-Intervention

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<thead>
<tr>
<th></th>
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<th>F-Up</th>
<th>Pre</th>
<th>Post</th>
<th>F-Up</th>
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</thead>
<tbody>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1. To exercise and walk at the gym twice a week</td>
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<td>1</td>
<td>6</td>
<td>6</td>
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<tr>
<td>2. No fall in one week</td>
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<td>1</td>
<td>4</td>
<td>6</td>
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<td>1</td>
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<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>1. Sleep through the night</td>
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<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>2. Help my daughter</td>
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<td>6</td>
<td>2</td>
<td>10</td>
<td>4</td>
<td>10</td>
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<tr>
<td>3. Walk alone without the cane</td>
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<td>1</td>
<td>4</td>
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<td>5</td>
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<tr>
<td>4. Get snack and transport it while walking alone</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>4</td>
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<td>5</td>
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<tr>
<td>Participant 3</td>
<td></td>
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</tr>
<tr>
<td>1. Cook for my wife</td>
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<td>1</td>
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<td>2. Sleep better</td>
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<td>4</td>
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Untrained Goals Set at Post-Intervention

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<th>F-Up</th>
<th>Pre</th>
<th>Post</th>
<th>F-Up</th>
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</thead>
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<tr>
<td>Participant 1</td>
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<td></td>
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</tr>
<tr>
<td>1. Do laundry by myself</td>
<td>5</td>
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<td>7</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>2. Do grocery shopping by myself</td>
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<td>5</td>
<td>8</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>3. To fit things into my schedule</td>
<td>10</td>
<td>3</td>
<td>8</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participant 2</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Type 100 words per minute on the keyboard</td>
<td>7</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>2. Find computer-related paid work</td>
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<td>1</td>
<td>5</td>
<td>1</td>
<td></td>
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<tr>
<td>3. Take a course</td>
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<td>5</td>
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<td>Participant 3</td>
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<td>3. Prepare photos to sell</td>
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</table>

I=Importance rating; F-Up=Follow-Up; N/A and shaded areas=Ratings not available.
All rating scales are from 1 to 10 (1=the least, 10=the most). A change of 2 is considered clinically significant (Law et al., 1998).
Appendix I: Secondary Outcome Measure Outcomes

**Mayo-Portland Adaptability Index-4 (MPAI-4), Participation Index**
Pre, Post, and Follow-Up Data

<table>
<thead>
<tr>
<th>Participant</th>
<th>Pre 1</th>
<th>Pre 2</th>
<th>Pre 3</th>
<th>Post 1</th>
<th>Post 2</th>
<th>Post 3</th>
<th>Follow-Up 1</th>
<th>Follow-Up 2</th>
<th>Follow-Up 3</th>
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<table>
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<tr>
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<th>Pre 2</th>
<th>Pre 3</th>
<th>Post 1</th>
<th>Post 2</th>
<th>Post 3</th>
<th>Follow-Up 1</th>
<th>Follow-Up 2</th>
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**Dysexecutive Questionnaire (DEX)**
Pre, Post, and Follow-Up Data

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<th>Pre 3</th>
<th>Post 1</th>
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<th>Pre 3</th>
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<th>Post 2</th>
<th>Post 3</th>
<th>Follow-Up 1</th>
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<th>Follow-Up 3</th>
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Note: N/A = Data not available
Appendix I: Secondary Outcome Measure Outcomes (Continues)

Flanagan’s Quality of Life Scale (QOL)
Pre, Post, and Follow-Up Data

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Overall Quality of Life Ratings at Pre, Post, and Follow-Up

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Life Space Questionnaires (LSQ)
Pre, Post, and Follow-Up data

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<th>Pre 2</th>
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<th>Post 1</th>
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<th>Post 2</th>
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Note: N/A = Data not available
**Appendix J: Secondary Outcome Measures Statistical Outcomes**

**Mayo-Portland Adaptability Index-4 (MPAI-4), Participation Index**

**Paired Samples Test**

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<th>Standard Deviation</th>
<th>Standard Error Mean</th>
<th>Lower</th>
<th>Upper</th>
<th>( t ) (Degree of freedom=2)</th>
<th>( p ) Significance (2-tailed)</th>
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<td>Pre-Post</td>
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Please Note: Participant 3 only completed 1 of 3 repeated weekly post-intervention assessment sessions. Thus, only one set of scores was available for analysis at post-intervention. To compare pre and post outcomes, the scores from the one assessment session were used as the mean scores to obtain the \( t \) and \( p \)-values for all secondary outcome measures for participant 3. (N/A=Data not available)
Appendix J: Secondary Outcome Measures Statistical Outcomes (Continues)

**Dysexecutive Questionnaire (DEX)**

Paired Samples Test

<table>
<thead>
<tr>
<th></th>
<th>Paired Difference</th>
<th>95% Confidence Interval of the Difference</th>
<th>t (Degree of freedom=2)</th>
<th>p Significance (2-tailed)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Standard Deviation</td>
<td>Standard Error Mean</td>
<td>Lower</td>
</tr>
<tr>
<td>Participant 1</td>
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</table>

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Appendix J: Secondary Outcome Measures Statistical Outcomes (Continues)

Flanagan’s Quality of Life Scale (QOL)

Paired Samples Test

<table>
<thead>
<tr>
<th></th>
<th>Paired Difference</th>
<th>95% Confidence Interval of the Difference</th>
<th></th>
<th>t (Degree of freedom=2)</th>
<th>p (Significance (2-tailed))</th>
</tr>
</thead>
<tbody>
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<td>Mean</td>
<td>Standard Deviation</td>
<td>Standard Error Mean</td>
<td>Lower</td>
<td>Upper</td>
</tr>
<tr>
<td>Participant 1</td>
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<td>Participant 3</td>
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</tr>
</tbody>
</table>

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Appendix K: Research Ethics Board Approval Letters

University of Toronto
Office of the Vice-President, Research
Office of Research Ethics

PROTOCOL REFERENCE #24377

August 20, 2009

Dr. Deirdre R. Dawson
Occupational Science and
Occupational Therapy
Kunin-Lunenfeld Applied
Research Unit Baycrest
3560 Bathurst Street
Toronto, ON M6A 2E1

Ms. Edith Ng
Occupational Science and
Occupational Therapy
Kunin-Lunenfeld Applied
Research Unit Baycrest
3560 Bathurst Street
Toronto, ON M6A 2E1

Dear Dr. Dawson and Ms. Ng:

Re: Administrative Approval of your research protocol entitled, “A real-world intervention for improving quality of life for adults with executive dysfunction following traumatic brain injury”

We are writing to advise you that the Office of Research Ethics has granted administrative approval to the above-named research study. The level of approval is based on the following role(s) of the University, as you have identified with your submission:

- Graduate Student research – hospital-based only
- Storage or analysis of De-identified Personal Information (data)

This approval does not substitute for ethics approval, which has been obtained from your hospital Research Ethics Board. Please note that you do not need to submit Annual Renewals, Study Completion Reports or Amendments to the ORE unless the involvement of the University changes so that ethics review is required. Please contact the ORE to determine whether a particular change to the University’s involvement requires ethics review.

Best wishes for the successful completion of your project.

Yours sincerely,

Daniel Gyewu
Research Ethics Coordinator

McMurrich Building, 12 Queen’s Park Cres. W, 3rd Floor Toronto, ON M5S 1S8
TEL: 416-845-3273 FAX: 416-845-5763 EMAIL: ethics.review@utoronto.ca
Appendix K: Research Ethics Board Approval Letters (Continued)

Baycrest
Research Ethics Board
3560 Bathurst Street
Toronto, ON M6A 2E1
Phone: (416) 785-2500 ext. 2190
Fax: (416) 785-2860

Notification of REB Approval

Date: April 2, 2009

To: Dawson, D., Polatajko, H., Lemskey, C., Levine, B., Streiner, D.

Re: A real-world intervention for improving quality of life for adults with executive
dysfunction following traumatic brain injury (REB# 06-12)

Sponsor: N/A
REB Review Type: Amendment
REB Initial Approval Date: March 13, 2006
REB Amendment Date: April 2, 2009
REB Expiry Date: March 13, 2010
Documents Approved: Revised Protocol, ICF (Version #5, April 2, 2009)
Documents Acknowledged:

The above named study has been reviewed and approved by the Baycrest Research Ethics Board. If, during the course of the research, there are any serious adverse events, confidentiality concerns, changes in the approved protocol or consent forms or any new information that must be considered with respect to the project, these should be brought to the immediate attention of the REB. In the event of a privacy breach, you are responsible for reporting the breach to the Baycrest REB and the Baycrest Corporate Privacy Office (in accordance with Ontario health privacy legislation – Personal Health Information Protection Act, 2004). Additionally, the Baycrest REB requires reports of inappropriate/unauthorized use of the information.

If the study is expected to continue beyond the expiry date, you are responsible for ensuring the study receives re-approval. The REB must be notified of the completion or termination of this study and a final report provided. As the Principal Investigator, you are responsible for the ethical conduct of this study.


Sincerely,

Angela Troyer, Ph.D.
Chair, Baycrest Research Ethics Board