ACQUIRED BRAIN INJURY AND NATURALISTIC STRATEGY USE: ANALYSIS OF STRATEGIES USED DURING COMPLETION OF THE MULTIPLE ERRANDS TEST
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ABSTRACT
This study furthers our understanding of naturalistic strategy use by ABI survivors with executive dysfunction. Strategies used by 14 stroke survivors, 12 TBI survivors and 25 matched controls on the Baycrest Multiple Errands Test (BMET) were scored. Relationships between strategy use and BMET performance were found for all groups ($r_s$=.30-.71). TBI participants experienced monitoring difficulties ($r_s$=-.38 to -.71). Greater use of task setting strategies was associated with better performance for all participants. Results support the theory of fractionation of the prefrontal lobes and the suggestion for further fractionation of the task setting and monitoring processes. Strategy use was consistently correlated with scores on the AMPS ($r_s$=.30-.75) indicating good ecological validity. Differences in patterns of strategy use between stroke and TBI participants suggest these types of ABIs do not affect real-world performance in the same way. This study indicates the importance of understanding naturalistic strategy use for cognitive rehabilitation after ABI.
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<th>Description</th>
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<tr>
<td>ABI</td>
<td>Acquired brain injury</td>
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<tr>
<td>AMPS</td>
<td>Assessment of Motor and Process Skills</td>
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<td>BADS</td>
<td>Behavioural Assessment of the Dysexecutive Syndrome</td>
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<td>BMET</td>
<td>Baycrest Multiple Errands Test</td>
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<td>DEX</td>
<td>Dysexecutive Questionnaire</td>
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<td>FSIQ</td>
<td>Full scale intelligence quotient</td>
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<td>MET</td>
<td>Multiple Errands Test</td>
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<td>MET-HV</td>
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<td>MPAI</td>
<td>Mayo-Portland Adaptability Inventory</td>
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<tr>
<td>NAART</td>
<td>North American Adult Reading Test</td>
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<td>NART</td>
<td>National Adult Reading Test</td>
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<tr>
<td>SET</td>
<td>Six Elements Test</td>
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<tr>
<td>SD</td>
<td>Standard deviation</td>
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<tr>
<td>SO</td>
<td>Significant-other</td>
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<td>TBI</td>
<td>Traumatic brain injury</td>
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<td>UK</td>
<td>United Kingdom</td>
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<td>V-MET</td>
<td>Virtual - Multiple Errands Test</td>
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<td>VMPC</td>
<td>Ventromedial prefrontal cortex</td>
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CHAPTER 1: Introduction

The main goal of this thesis research was to further our understanding of how acquired brain injury (ABI) patients with executive dysfunction naturally employ strategies as they attempt to complete a task. Understanding naturalistic strategy use in this population is important because much of cognitive rehabilitation involves teaching patients strategies to achieve their goals (Cicerone et al., 2000). Strategies are defined as elements of behaviour which add to the effectiveness and efficiency of a person’s performance (Toglia, 2003). Selecting and applying appropriate strategies will help move a person towards their goal.

Making and carrying out a plan (Allain et al., 2005), multitasking, decision making (Burgess, 2000), and monitoring ones’ own behaviour (Stuss, 1992) are all executive type behaviours involved in real-world strategy use. When the prefrontal lobes are damaged, it often results in executive dysfunction. Also, the prefrontal lobes rely on a widespread neural network to function, and as a result, damage to non-frontal brain areas that are part of this network can lead to problems associated with executive behaviours.

Chapter 2 in this thesis provides the background literature review. A major section of this chapter covers the primary theories of executive function in order to draw on these theories to explain patterns of strategy use in people with ABI compared to behaviour in healthy controls.

In order to observe naturalistic strategy selection and use in healthy and ABI participants, a real-world assessment tool, the Multiple Errands Test (MET), was used. The MET relies on the presentation of a series of ill-structured problems designed to mirror tasks encountered in day to day life. The MET is unlike many of the traditional tests of executive functioning in that it has good ecological validity (Dawson et al., 2005; Dawson et al., accepted); that is performance on this test is a good predictor of performance in the real-world (Chaytor & Schmitter-Edgecombe, 2003). Analyzing naturalistic strategy use and selection in ABI patients will provide valuable information about their approach to everyday tasks. In turn, this information can assist health care providers in designing more effective rehabilitation strategies for patients exhibiting problems with everyday, real-world functioning.

This thesis is organized in a manuscript format. Chapter 3 will be submitted for publication while chapter 4, although in manuscript format as well, is comprised of
additional data not intended for submission. Chapter 5 is a general discussion that ties in the findings reported in chapters 3 and 4 with the background provided in chapter 2. A final conclusion chapter then summarizes the key findings.
CHAPTER 2: Literature Review

Introduction

This chapter presents background information relevant to the study of naturalistic strategy use in survivors of ABI with executive dysfunction. Executive dysfunction impacts one’s strategy use abilities and is often associated with damage to the prefrontal lobes. This brain region and its involvement in strategy use are described. To our knowledge, the application of a theory of executive functioning to naturalistic strategy use investigations has not been previously conducted. Therefore, as part of this theory-based strategy use investigation, this chapter explores some of the major theories regarding executive functioning and how their application can drive strategy use research. A real-world environment is required if strategy use is to be assessed naturalistically and in an ecologically valid manner. The importance of this is discussed along with previous research on an ecologically valid assessment of executive function requiring participants to strategize for themselves, the Multiple Errands Test (MET). Strategy use is defined and reviewed, and its importance for cognitive rehabilitation is discussed.

The Prefrontal Lobes

The prefrontal lobes are located at the anterior region of the primate brain. They are most developed in the human brain (Petrides & Pandya, 2002) and comprise about 30% of its total volume (Huey et al., 2006). Although it is clear that executive function and strategy use are associated with the prefrontal lobes, the complete range of prefrontal functions has yet to be fully explicated. There is no prefrontal homunculus (Stuss, Shallice, Alexander, & Picton, 1995) and the prefrontal lobes consist of many architectonically different parts (Petrides & Pandya, 2002) which are widely interconnected with other brain areas (Cummings, 1995), allowing for the integration of information between various neuroanatomical sources. These factors contribute to the difficulties associated with studying prefrontal lobe function. This brain area has been found to mediate several major types of functions but the executive functions are the main focus in naturalistic strategy research as they are necessary for appropriate goal achievement and purposeful functioning in everyday, real-world situations (Cicerone et al., 2005). These are functions such as reasoning, decision making, planning,
interacting socially, creativity (Huey, Krueger, & Grafman, 2006), monitoring ongoing behaviours (Stuss, 1992), and managing daily life situations (Zalla, Plassart, Pillon, Grafman, & Sirigu, 2001). The prefrontal lobes are also involved in identifying which stimuli are appropriate to the situation and actively stifle irrelevant stimuli during purposive behaviours (Barbas & Zikopoulos, 2007). A person’s level of ability with these executive functions will ultimately impact their capability to select and use appropriate strategies in their daily lives, making the prefrontal lobes and their interconnections our main areas of neuroanatomical interest.

When studying human behaviour, there are three prefrontal lobe circuits of particular interest: the orbitofrontal-subcortical circuit, the medial frontal-subcortical circuit, and the dorsolateral prefrontal-subcortical circuit (Cummings, 1995). A similar pattern is seen with these three circuits, as all incorporate an area of the prefrontal lobes, the striatum, the globus pallidus, and the thalamus. They also include afferent and efferent connections with brain areas that are not part of this main circuit, but are related to its main function. The orbitofrontal areas of the prefrontal cortex are important for assessing the emotional importance of a stimulus (Barbas & Zikopoulos, 2007) and the orbitofrontal-subcortical circuit is involved with social behaviours (Cummings, 1995). It starts in the orbitofrontal cortex and then connects to the ventral caudate, the globus pallidus, the substantia nigra, and the ventral anterior and dorsal medial thalamic nuclei. In line with their functional specialty, the orbitofrontal cortices are well connected with the amygdala (Cummings, 1995; Barbas & Zikopoulos, 2007) and damage to this circuit often may lead to disinhibited or impulsive behaviour (Cummings, 1995). The second circuit, the medial frontal-subcortical circuit, controls motivation (Cummings, 1995). It starts in the anterior cingulate cortex and consists of the nucleus accumbens, the globus pallidus, and substantia nigra as well as the medial dorsal thalamic nucleus. Some of the important afferents and efferents of this circuit are the amygdala and the hippocampus (Barbas & Zikopoulos, 2007). Interruptions to this circuit typically produce apathy, decreased interest and motivation, and low activity maintenance (Cummings, 1995). The third circuit, the dorsolateral prefrontal-subcortical circuit is involved in complex executive behaviours such as planning, applying programs for goal achievement, monitoring and adjusting or stopping actions (Cummings, 1995; Royall et al., 2002). It begins in the dorsolateral prefrontal area, and connects to the dorsolateral part of
the caudate nucleus, the globus pallidus, the substantia nigra, as well as the ventral anterior and medial dorsal thalamic nuclei (Cummings, 1995). The symptoms or deficits that emerge after injury to this circuit will depend on the specific regions within it that were affected (Cummings & Miller, 2007). Patients with executive dysfunction can exhibit one or any combination of executive deficits. For example, memory deficits, poor strategy use when planning is impaired, perseveration when the adjusting and stopping processes are not functioning properly, or distractibility if the patient is unable to self-monitor effectively (Cummings & Miller, 2007).

As reviewed above, prefrontal lobes are associated with many higher-order, everyday behaviours requiring executive functions. Due to the frequent association of executive functions with the prefrontal lobes, terms like “prefrontal lobe functions” have been used synonymously with terms like “executive functions”. However, it is not appropriate to assign an anatomical name (“prefrontal lobe functions”) to a psychological phenomenon (“executive functions”) (Stuss, 1992; Stuss et al., 1995; Stuss & Alexander, 2000; Stuss & Alexander, 2007). Impairments in these behaviours are seen not only after frontal injuries but are also evident after diffuse injuries or injuries to structures that communicate valuable information to and from the prefrontal lobes. At the same time, executive functioning is only one aspect of the prefrontal lobes’ role and damage to these brain areas will ultimately lead to various patterns of problematic behaviours.

Regardless of what these behaviours and functions are called, it is important to study them because their disruption can result in a major detrimental impact on a person’s functioning in everyday life. The prefrontal lobes are very sensitive to brain injury and the resulting behavioural dysfunctions are the most prevalent problem seen by neuropsychologists (Stuss & Levine, 2002). Their high degree of sensitivity to brain damage is in part attributed to the fact that they are held in place by the rough surfaces of the anterior cranial fossa. Although this serves a protective purpose for everyday activities that involve movement or slight contact with the head, this makes them more vulnerable to TBIs, such as from a major fall or motor vehicle accident (Bigler, 2007). In those situations, the bony ridges of the fossa can scrape the underside of the prefrontal lobes often resulting in damage. When a TBI occurs, forces are applied to the brain causing it to twist and move within the
skull. This can lead to shearing of the brain tissue, and thereby to diffuse axonal injury and vascular injuries.

The prefrontal cortices are also vulnerable to strokes of the middle cerebral artery (lateral prefrontal cortex) and anterior cerebral artery (medial prefrontal cortex), as well as aneurysms of the anterior communicating artery, which lead to hemorrhagic infarcts in the prefrontal and basal forebrain areas (Levine, Turner, & Stuss, 2008). Damage to these areas can result in a wide-range of executive problems that can significantly impact the patient’s everyday life.

In summary, functions crucial to everyday functioning, such as planning, monitoring behaviour, and decision making are often associated with the prefrontal lobes and are frequently referred to under the umbrella term of “executive functions”. In this thesis, I use the term executive function to describe these behaviours and recognize the major role of the prefrontal lobes in these functions. I also acknowledge that these same behaviours can be disrupted by damage to areas that are connected with the prefrontal lobes and by diffuse brain damage. Regardless of the term used to describe these behaviours and their neuroanatomical correlates, the fact remains that the results gained from this study are still important in that they can be applied in cognitive rehabilitation for patients with difficulties in everyday life functioning.

**Theories Related to the Executive Functions of the Prefrontal Lobes**

There are many theories and models related to the executive functioning of the prefrontal lobes. Some consider the prefrontal lobes as a globally acting unit while other theories attribute definite areas of the prefrontal lobes to specific functions. Duncan’s adaptive coding model and Baddeley’s central executive theory adopt the first position while Norman and Shallice’s Supervisory System Theory and Stuss and colleagues’ theory on the fractionation of the Anterior Attentional System illustrate the latter. These four theories are described below along with their relation to naturalistic strategy use.

**Duncan’s Adaptive Coding Model**

Originally, Duncan (1995a) linked the functioning of the prefrontal lobes to Spearman’s concept of general intelligence, or Spearman’s g (Spearman, 1927). Spearman’s g refers to the matrix of positive correlations obtained when a series of cognitive tests is administered to
a broad sample of individuals. In other words, those individuals who perform well on one test generally performed well on other tests and vice-versa, suggesting that there is a latent potential mediating performance across tests (Spearman, 1927). Symptoms after damage to the frontal lobes are diverse and many aspects of behaviour such as planning, memory, social judgment, and the ability to inhibit and to avoid distractions may be affected (Luria, 1966). “Executive” aspects of working memory, novelty of behaviour, and goal neglect have all been associated with $g$ and ultimately with the diverse nature of symptoms following frontal lobe injury (Duncan, Burgess, & Emslie, 1995b). In a series of experiments, Duncan and colleagues (1996) investigated goal neglect in normal subjects with varying $g$ and in patients with damage to the frontal lobes. Goal neglect was strongly displayed in the frontal patients and was related to $g$ in the normal population (with lower $g$ subjects exhibiting goal neglect). These results led Duncan to propose that areas of the prefrontal lobes possess a neural flexibility, allowing them to be recruited for different tasks, and that their coordination is responsible for the global functioning of the prefrontal lobes.

In 2002 Duncan and Miller presented a revised version of the adaptive coding model (Duncan & Miller, 2002) which recognized that there were some important regional specifications within the prefrontal lobes. Yet they still suggested that the division of the prefrontal lobes into more defined regions, each responsible for a specific cognitive process might not be possible. Instead, the adaptive coding model suggests that the prefrontal lobes function more generally, like a computational resource that can adapt to solve various cognitive problems. The model is based on three key points: 1) neurons adapt to address the present behavioural needs, 2) the prefrontal lobes function as a global attention system that focuses on information that is relevant for the current situation, and 3) the information deemed relevant controls the function of other brain regions, allowing this flexible system to function coherently when addressing the situation at hand.

Duncan and Owen’s (2000) analysis of prefrontal functional neuroimaging data contributed to the development of this model and provided further support to the theory that regions of the prefrontal lobe adapt their function depending on the situation. The analysis compared which areas of the prefrontal lobes were recruited for five different executive type cognitive demands (e.g., executive control, working memory and problem solving) associated with prefrontal lobe functioning. Their results showed clusters of activation
limited to specific regions of the prefrontal lobes, regardless of the cognitive demands studied, as well as total overlap of the areas activated for each of the five different types of cognitive demand. These results suggested that similar patterns of prefrontal regions were involved in addressing different cognitive needs. However, these results were obtained by combining data from published studies, meaning that the participants, methods employed, and analysis techniques differed from one study to the next. Also, Duncan’s work fails to provide evidence of a mechanism behind the adaptive coding model. He does not address how the neurons go about adapting and focusing on the relevant information for the flexible system to function coherently.

**Baddeley’s Central Executive Theory**

The central executive is a subcomponent of Baddeley’s working memory theory (Baddeley, 1986) (Figure 2.1). Originally, there were three subcomponents posited: 1) the phonological loop to process speech based information, 2) the visuo-spatial sketch pad to process visuo-spatial information, and 3) the central executive to manage the attentional control aspect of working memory and coordinate the other two subsystems. The model has since been further developed to include a fourth subcomponent, the episodic buffer. This subcomponent represents the environment, makes the environment available to conscious awareness, and allows accessibility to long-term memory so that previous experiences can be used to model future ones (Baddeley, 2000; Baddeley, 2002).

![Figure 2.1 Baddeley's working memory model (Baddeley, 2003; © Nature Publishing Group, see Copyright Acknowledgment A)](image)
The focus for this thesis is on the most poorly elucidated of the sub-components, the central executive. As mentioned earlier, the central executive manages the attentional control aspect of working memory, but more specifically it is involved in focusing attention to prevent distraction by irrelevant stimuli, switching attention between stimuli, dividing attention for multitasking, and interacting with long-term memory (Baddeley, 1996).

Support for the executive control of the central executive comes from studies of task-switching (Baddeley et al., 2001), random generation, selective attention, and activation of long-term memory (see Baddeley, 1996 for review of the latter three). However, much of the evidence for the executive control of this subcomponent comes from researching dual-tasking. This was tested with a task that requires the person to use their phonological loop and visuo-spatial sketch pad simultaneously, for example when required to maintain contact between a stylus and a moving spot of light while recalling a sequence of digits (Baddeley, 1986). Baddeley hypothesized that a malfunctioning central executive would lead to poor dual-tasking ability due to improper coordination of the speech and visuo-spatial information. This was initially tested using patients with dementia of the Alzheimer type who exhibited problems with executive functioning (Baddeley, 1986). When compared to age-matched controls, the patients with dementia showed a decrement in dual-task performance. Similar results were found with patients with Parkinson’s disease (Dalrymple-Alford, Kalders, Jones, & Watson, 1994) and ABI (Hartman, Pickering, & Wilson, 1992), demonstrating that this phenomenon is not specific to patients with dementia. The dual-tasking paradigm was also used to identify the central executive’s neural correlates. Patients with frontal lobe damage were divided into two groups based on whether or not they exhibited behaviours associated with executive dysfunction (Baddeley, Della Sala, Papagno, & Spinnler, 1997). The task required participants to simultaneously draw crosses in a chain of boxes and recall digit sequences. Results showed that dysexecutive behaviours following a lesion of the prefrontal lobes were indeed associated with decrements in dual-task performance.

Dual-tasking functions of the central executive have been linked to the prefrontal lobes. However, attempts at fractionation (Baddeley, 1996; Baddeley, 2002), have yet to assign defined brain areas to this, or to other, specific functions of the central executive. According to Baddeley, the model continues to be useful even without evidence of its
neuroanatomical correlates (Baddeley, 1996) and the central executive remains a sort of “ragbag” (Baddeley, 1996) presumed responsible for complex functions such as strategy selection, planning, and retrieval checking.

**Supervisory System Theory**

This theory, originally developed by Norman and Shallice in 1986, postulated that the prefrontal lobes house a single overriding system, the supervisory system, which performs multiple processes and interacts with other subsystems to produce an integrated function during novel non-routine situations (Norman & Shallice, 1986). Although it is still viewed as one system, it is now considered to carry out several different processes (Shallice & Burgess, 1996). Figure 2.2 illustrates the revised model with its three stages and the eight processes within them (Shallice & Burgess, 1996; Shallice, 2002). Stage 1 involves generating a temporary new schema, or strategy. Strategy generation can occur spontaneously, which means the strategy came to mind after the previous strategy was found to be unsatisfactory, or via ‘problem-solving’. Stage 1 is also when strategies are formed and used at a future time and when relevant episodic memories are accessed. Stage 2 is when the strategy is implemented and held active in working memory. Stage 3 is when the strategy’s effectiveness is monitored and evaluated so that it can be altered appropriately or rejected.
Evidence from lesion and imaging studies, such as those by Stuss and colleagues described in the next section, provide support for the fractionation of the adapted Supervisory System (Figure 2.2). These results suggest that the modulation of schemas/strategies (process 3) appears to be localized in the left dorsolateral prefrontal cortex with monitoring and checking (process 2) in the right dorsolateral prefrontal cortex. The right ventrolateral prefrontal cortex seems to be involved in the specification of a needed memory trace (process 8) and Brodmann area 10 has been associated with the formation of intentions for delayed use and their realization (process 7) (evidence reviewed in Shallice, 2002). However, many of these studies were not originally designed to investigate the fractionation of the Supervisory System and were applied as supporting evidence after the fact. The way the processes function remain hypotheses as studies to prove the model’s functioning have yet to be undertaken.
Fractionation of the Anterior Attentional System Theory: Stuss, Shallice, Alexander, and Picton

This theory began with the conjecture that there is not just one prefrontal process but a multitude of processes that work together and are mediated by different areas of the prefrontal lobes (Stuss et al., 1995). Using Norman and Shallice’s supervisory system (Norman & Shallice, 1986) as a starting point, Stuss and colleagues developed a research program allowing the prefrontal processes to be further fractionated and defined (Stuss & Alexander, 2007; Stuss et al., 1995). Only patients with a single focal frontal lesion were recruited as the goal of this work was to determine if lesions in different prefrontal areas affect task performance differently. The results of these studies led Stuss and colleagues to suggest the presence of 4 categories of prefrontal lobe functions: energization, behavioural self-regulation, metacognition, and executive (made up of task setting and monitoring) (Stuss & Alexander, 2007). Of particular interest in this thesis are the executive capacities of task setting and monitoring. Task setting, the ability to set a stimulus-response relationship, was found to depend on an intact left lateral prefrontal lobe (Alexander, 2006; Alexander et al., 2007; Stuss et al., 2002; Stuss & Alexander, 2007). Monitoring, which involves checking performance throughout task completion to ensure quality and making any necessary adjustments, was affected by lesions to the right lateral frontal lobe (Picton et al., 2006; Picton et al., 2007; Stuss et al., 2002; Stuss & Alexander, 2007).

In summary, this theory postulates that there is no unitary frontal process and therefore no ‘frontal lobe syndrome’. Although Stuss and colleagues have found evidence of fractionation of prefrontal lobe processes, their theory also states that these processes are not independent (Stuss & Alexander, 2007). Depending on the task at hand and its associated demands, different frontal processes are integrated with each other and/or with posterior processes to meet task demands.

When looking at all four of these major theories of executive functioning together we see that Duncan and Baddeley’s theories currently see the frontal lobes as having a more general supervisory function and a lack of neuroanatomical specification while the other two theories provide evidence for the fractionation of the prefrontal lobes. The neural correlates associated with Norman and Shallice’s processes can be related to the work of Stuss. Both theories agree that monitoring and checking are located in the right lateral prefrontal. Task setting, which Stuss argues to be localized in the left lateral prefrontal lobe, is similar to the
process of rejecting and adjusting a schema (process 3) proposed by Norman and Shallice. Most importantly, these two independent theories highlight the importance of the left lateral prefrontal lobe as a mediator in these types of complex behavior.

Unlike with the adaptive coding model and the supervisory attention system, Stuss’ theory on the fractionation of the prefrontal lobes was tested using a research program specifically designed for the fractionation of the prefrontal lobes’ functions. Using this program, Stuss and colleagues extensively studied the processes of the prefrontal lobes and clearly defined them operationally and neuroanatomically (see the summary of many years of work in Stuss & Alexander, 2007). Two of these prefrontal processes, task setting and monitoring, are considered to be executive capacities (Stuss & Alexander, 2007). Both are important for task completion and deficiencies in one or the other would likely result in strategy use differences. Identification of which process is problematic for a person would allow clinicians to target their rehabilitation efforts appropriately. Since this thesis involves ABI survivors with executive dysfunction, those two processes were deemed relevant and served as a good theory base for the investigation of naturalistic strategy use in this population.

**Real-world Performance and Ecological Validity**

When assessing real-world behaviours, such as naturalistic strategy use, it is important for assessments to be ecologically valid. In neuropsychology, the term ecological validity is used to describe a test’s ability to predict real-world performance (Chaytor & Schmitter-Edgecombe, 2003).

Most traditional tests of neuropsychology originally emerged from experimental investigations (Burgess et al., 2006). According to Chaytor and Schmitter-Edgecombe (2003), these same tests are now being used to predict a patient’s cognitive abilities and to determine whether they can return to work or school, live on their own, or drive a motorized vehicle. However, there is growing literature that shows that traditional neuropsychology tests of executive functioning have a limited association with performance in the real-world.

Chaytor and colleagues (2006) investigated the ecological validity of four commonly used tests designed to measure executive functioning: the Trail Making Test, Wisconsin Card Sorting Test, Stroop and Controlled Oral Word Association Test. They administered the
tests to 46 adults with a variety of diagnoses (e.g., epilepsy, TBI, vascular accident or malformation, multiple sclerosis, or tumor) who had been referred for neuropsychological testing. They also administered the Dysexecutive Questionnaire (DEX) and the Brock Adaptive Functioning Questionnaire as measures of everyday executive functioning. Multiple regression analyses indicated that performance on the traditional tests of executive functioning accounted for only 18-20% of the variance in everyday executive abilities. Similarly, we (Andre et al., 2008) previously studied 26 TBI and stroke participants to see how their performance on four traditional neuropsychology tests of executive functioning (e.g., Wisconsin Card Sorting Test, Trail Making Test Part B, Digit Symbol and Controlled Oral Word Association Test) correlated with scores on two measures of daily life abilities (e.g., DEX and the Mayo-Portland Adaptability Inventory) administered to their significant-other. We found that measures of executive functioning only explained modest amounts of variation in daily life performance and it was concluded that they had limited ecological validity when used in that context.

Moreover, Burgess and colleagues (1998) analyzed the ecological validity of tests on executive function using 92 mixed etiology neurological patients and 216 healthy controls. The DEX self and significant-other reports were used as measures of real-world executive functioning while the Wisconsin Card Sorting Test, Cognitive Estimates Test, Verbal Fluency and Verbal Fluency for Animals, the Trail Making Test, and the Simplified Six Element Test were the traditional neuropsychological assessments of executive function used. Their results suggested that poor performance on the traditional neuropsychological tests of executive functioning was related to impairments in everyday life as measured by the significant-other version of the DEX. However, although significant, the correlations were weak, ranging from .29 to .40, meaning that these relationships accounted for only up to 16% of the variance in everyday executive functioning.

The discrepancies between real-world and neuropsychological test performance reported in the above examples likely result from the test format and environment. Unlike the real-world, neuropsychological tests are comprised of short trials with usually only one problem to be solved at a time and with the patient being prompted by the administrator (Shallice & Burgess, 1991). The patient is generally not required to multitask or prioritize for him or herself (Manchester, Priestly, & Jackson, 2004), and the testing is conducted in an
environment that is artificial, structured, and quiet, with as few distractions as possible (Chaytor & Schmitter-Edgecombe, 2003).

In summary, neuropsychologists are frequently asked to assess a patient in order to identify impairments and the implications that these may have on everyday life. However, the traditional tests used in neuropsychology assessments may not be sensitive enough to identify real-world impairments in these patients. Therefore, making real-world predictions based on these test scores may not be valid (Manchester et al., 2004) and new assessments of executive function that are generalizable and representative are needed (Burgess et al., 2006). Ultimately, good ecological validity of neuropsychological tests will be especially important in the field of rehabilitation where clinicians rely on these tests in order to plan rehabilitation programs and assess their efficacy.

Recently, the importance of this has become better understood and in the last 20 years, many attempts have been made to develop tests that measure prefrontal functioning in a more ecologically valid way, e.g., the Behavioural Assessment of Dysexecutive Syndrome (Wilson, Evans, Emslie, Alderman, & Burgess, 1998), the Six Elements Test and the Multiple Errands Test (Shallice & Burgess, 1991). The Multiple Errands Test (MET) is especially interesting in that it places the person in a real-world setting and requires them to complete real-world tasks. Thus, it is reflective of the types of real-world difficulties patients experience in their day-to-day lives and also serves to characterize the way people with executive dysfunction perform in the every day world.

**Multiple Errands Test**

The multiple errands test (MET) was originally developed by Shallice and Burgess in 1991. It was designed to capture a person’s real-world executive abilities, thereby addressing some of the ecological validity problems previously associated with the tests traditionally used in this field. The MET has a series of simple sub-goals that need to be completed by the participant as well as a list of rules which must be followed. It is an ill-structured task which is administered in a real-world environment. It is also open-ended, requiring the participants to plan for themselves in order to complete the tasks efficiently.

The version of the MET used by Shallice and Burgess (1991; Appendix A) was administered in a pedestrian precinct and included 8 tasks varying in complexity. Examples
of some of the tasks are buying a loaf of brown bread, being at a specific meeting point 15 minutes into the test and gathering information, such as the name of the coldest place in Britain the day before, which was then to be written on a postcard. Prior to starting the MET, all participants were required to understand and memorize a set of rules that they were to follow during task completion. The rules were that they should spend the least amount of money possible and complete the tasks in any order and as quickly as possible without rushing. They were also to enter a shop only if something was to be bought and then tell an experimenter what was bought in that shop. Only a wrist watch or items item bought during the course of the exercise could be used to help with the completion of the test.

Shallice and Burgess (1991) administered this version of the MET to three TBI patients and nine control participants which were matched to the patients based on age and National Adult Reading Test (NART) scores. The patients had a TBI involving prefrontal structures, preserved IQ, good performance on a series of language, perception, and general cognition tasks but experienced organizational problems in their everyday lives. Two out of the three performed well on traditional frontal lobe tasks. When given the MET, all 3 patients performed at or below the fifth percentile when compared to controls for the number of rules broken during task completion and the number of inefficiencies produced (that is, using a poor strategy in place of a more effective one). These results reflected the patient’s report of everyday problems with multiple sub-goal tasks encountered in the “real world”.

This first version of the MET was administered to patients with average to above average general cognitive abilities and since then, a simplified version of the MET has been developed (Alderman, Burgess, Knight, & Henman, 2003) for use with patients representing the wider range of cognitive abilities generally encountered clinically (Appendix B). The simplified version was first administered in a shopping center in the UK to 50 ABI patients and 46 controls. The patients’ performance on other tasks of general cognition was variable, thereby making this sample more representative of what is usually seen in clinical practice. This simplified version had rules that were less abstract, simpler sub-goals and space on the instructions sheet where collected information could be written down by the participants. This version of the task was found to have good ecological validity and effectively discriminated patient and control subjects (patients averaged 3 times more errors than controls). A cut-off score of 12 errors or more allowed correct classification of 82% of the
ABI participants. Types of errors made allowed for further division of the patients into 2
groups: the “rule breaker” and the “task failure” groups. This division related to the patients’
real-world, everyday behaviours as reported by caregivers and relatives.

A hospital version of the MET (MET-HV) was also developed in the UK (Knight et al.,
2002, Appendix C, Copyright Acknowledgment C). This made the MET accessible to
patients who might not be able to perform the test in a public place (e.g., due to mobility or
behavioural problems, or those not allowed to leave the hospital). It was tested on 20 ABI
patients and 20 age, gender and NAART-R FSIQ matched controls. To ensure its
applicability with the general clinical population, the MET-HV was modeled after the
simplified shopping MET created by Alderman et al. The MET-HV was found to be reliable,
with an inter-rater reliability ranging between .81 and 1.00 depending on the type of error
being measured and an internal consistency of .77. Ecological validity was also examined.
Participants’ errors on the MET-HV were compared with their scores on tests and
questionnaires said to be ecologically valid measures of everyday executive functioning.
Significant correlations in the expected direction were found between the MET-HV task
failures, interpretation failures and total errors, and the Behavioural Assessment of the
Dysexecutive Syndrome (BADS; Wilson, Alderman, Burgess, Emslie, & Evans, 1996)
battery profile score. Significant correlations in the expected direction were also found
between scores on the Dysexecutive Questionnaire (DEX; Burgess, Alderman, Wilson,
Evans, & Emslie, 1996), as filled in by a professional staff member at the hospital who knew
the participant well, and the number of task failures on the MET-HV. These findings
strengthen the argument that the MET possesses good ecological validity and further
suggests that it may be a good predictor of everyday executive problems in clinical
populations. This version of the MET also discriminated well between patients and controls
(i.e., patients broke more rules and made more errors while completing less sub-tasks) with at
least 85% of patients being correctly classified when using a cut-off score of 7 or more
errors.

Tranel et al. (2007) developed and administered a shopping mall version of the MET to
17 patients with damage to the prefrontal lobes, 17 patients with damage to a brain area other
than the prefrontal lobes, and to 20 healthy controls. They were interested particularly in the
performance of nine patients with damage to the ventro-medial prefrontal cortex (VMPC).
Their results indicated that prefrontal lobe damage in general led to poorer performance on the MET in the form of more errors and fewer tasks completed, and that damage to the VMPC led to the worst performance.

A virtual shopping MET (V-MET) has been developed and compared to the MET administered in a real shopping mall (Rand, Rukan, Weiss, & Katz, 2008). It was administered to nine post-stroke participants, 20 young healthy controls and 20 older healthy controls. Significant correlations between MET and V-MET performance for the post-stroke and older control groups are indicative of the V-MET’s good ecological validity and usefulness as an assessment tool for executive functioning. The V-MET also had good discriminative ability as it was able to successfully discriminate the post-stroke participants from the healthy controls and differentiate the young from older healthy participants. Although further research will be needed before it can be successfully implemented clinically, the V-MET results look promising in that a virtual testing environment provides less environmental variability, shorter testing time, and can be administered even to participants with motor difficulties who could not maneuver their way through a real mall or a hospital.

Another version of the MET was later adapted from the MET-HV for use at the Baycrest Center in Toronto, Ontario, Canada (Dawson et al., accepted, Appendix D). It was administered to 27 ABI participants (14 with stroke and 13 with TBI) and to 25 control participants matched for age, gender, and education. Performance analyses found that participants in the stroke group completed fewer tasks, committed more total errors, and had more rule breaks than their control participants. Weighted task error scores were calculated separately for stroke participants and their controls than for TBI participants and their controls by giving each error a score of 1 (errors made by up to 95% of controls), 2 (made by less than 5% of controls), or 3 (errors made by brain injured participants but not seen in controls). Results indicated that the TBI group had significantly more weighted task errors than their control participants. Several other scores indicated a trend towards worse performance for those in the ABI groups and despite not being statistically different from their controls on those scores, moderate to high effect sizes (Cohen $d = 0.54 – 0.98$) were reported suggesting their importance. The same study also looked at the psychometric and ecological validity of the Baycrest MET (BMET). Intra-class correlations of .71 or higher
between raters on all the BMET performance measures indicating excellent inter-rater reliability, while moderate to high correlations between BMET performance measures and scores on measures of daily life ability and participation suggested it had good ecological validity. As a whole, the BMET was found to discriminate reasonably well between cases and their controls with excellent inter-rater reliability and ecological validity.

Overall, the positive findings associated with the MET are encouraging. They indicate that the test can be adapted to various real-world settings, allowing it to be accessible to a large proportion of the clinical population, and further suggest that the MET has excellent psychometric and good ecological validity, that is, it is highly associated with patients’ everyday, real-world abilities. However, assessments of executive functioning, including the MET, have previously characterized a person’s functioning in the real-world by their performance errors and little attention has been given to the strategies that are naturally employed throughout test completion.

**Naturalistic Strategy Use**

Teaching strategies to ABI survivors who suffer from executive dysfunction can help them overcome their problems as well as play an important role in their cognitive rehabilitation. However, surprisingly little research has been done to understand naturalistic strategy use in this population. A better understanding of this would better inform strategy training rehabilitation, potentially enhancing its effectiveness.

Strategies are defined as elements of behaviour which add to the effectiveness and efficiency of a person’s performance (Toglia, 2003). Selecting and applying appropriate strategies help move a person towards their goal. They can be external, such as using aids or cues from one’s external environment, or internal, such as self-talk or mental repetition. Some strategies are situational, meaning that they are effective for a particular situation, while others can be applied in a variety of situations (Toglia, 1991). Pressley et al. (1990) add that when first learning a new strategy, the user intentionally chooses it and remains aware of this choice. Over time, practice automatizes the use of this strategy, though it can still be consciously controlled if desired (Pressley et al., 1990). Solving a problem can often be done multiple ways, leading to various strategies being used to yield the same solution.
This contributes to the highly complex and diverse nature of strategy use, which often makes experimental study of strategy use difficult.

Edith Kaplan’s work (Kaplan, 1988) was largely influential in pointing out the importance of analyzing the process (i.e., strategies) used by patients to solve problems they were presented with during a neuropsychological assessment. Her work led to the development of the Boston Process Approach to Neuropsychological Assessment (Milberg, Hebben, & Kaplan, 1996). This approach placed emphasis on observing and analyzing the strategies patients used when completing a neuropsychological test. Kaplan would observe and note every move her patients made and analyze the process by which they completed the tests. However, these data were largely observational and there was little empirical evidence to support if and how the behaviours observed were related to brain injury (Milberg & Hebben, 2006). In addition, there is also a lack of evidence to support the generalizability of performance on these neuropsychological tests to performance in everyday, real-world situations (Milberg & Hebben, 2006).

Poreh (2000) has since attempted to further the Boston Process Approach by standardizing the analysis of strategies used by patients during a neuropsychological assessment through the Quantified Process Approach. The underlying notion for both the Boston and the Quantified Process Approach is the same: that different people will use different strategies to solve the same problem. Progress in the quantification of processes used to complete neuropsychological tests has been made (Poreh, 2006) but due to the large variation of strategies possible, much more research in this area will be needed if an empirical science of strategy choice can be developed.

In this thesis research, we investigated strategy use on a real-world task. Participants were not instructed to use specific strategies to complete their tasks because the focus was on naturalistic or spontaneous strategy use by the participants. Much of the previous work on naturalistic strategy use has been done on children and has used self-reports or reports from parents as measures of strategic tendencies (see Pressley et al., 1990 for review). Of interest to this thesis is previous research that has alluded to the importance of better understanding naturalistic strategy use in the ABI population with damage to the prefrontal lobes, which as mentioned earlier have been found to be involved with executive functions necessary for appropriate goal achievement and purposeful functioning in everyday, real-world situations.
(Cicerone et al., 2005). This body of work is small and generally describes the use of assessments that simulate a real-world situation, such as a financial planning task requiring a participant to balance a family budget (Goel et al., 1997) or a paper-and-pencil task where appropriate strategy application leads to more efficient task completion (Levine et al., 1998). Results from this work show that people with damage to the prefrontal areas lack cognitive flexibility and tend to focus on using only one strategy (Goel et al., 1997). They are unable to envision the most efficient strategy and inhibit their natural responses during a strategy engaging task (Colvin et al., 2001; Levine et al., 1998). They also have problems with the mental representation of possible solutions and have difficulty with the concept of breaking away from the most obvious strategy to perform moves that seem counterintuitive but are actually necessary for task completion (Colvin et al., 2001). Overall, participants with damage to the prefrontal lobes perform poorly on strategy application tasks when compared to healthy controls or participants with non-frontal injuries (Colvin et al., 2001; Goel et al., 1997; Levine et al., 1998; Tranel et al., 2007).

In this study, rather than using a test designed to simulate a real-world situation, I examined strategy use in a real-world situation by using the MET. This allowed me to study spontaneous strategy use while people were doing tasks that they would do in everyday life. This made it possible to observe people in a real-world environment and record spontaneous strategy use.

Although previous MET research has generally focused on the analysis of performance errors (as was described in the previous section), preliminary work on strategy use during MET completion suggests that patients’ selection and use of strategies differs from that of the normal population. Requesting help is one possible strategy that could be used during MET completion. This strategy was more commonly used among participants with stroke than their controls in a study by Dawson and colleagues (accepted). Alderman and colleagues (2003) also found that more people in their brain injured group (80%) used this strategy compared to controls (54.3%) yet when correlating the number of requests for help with the number of tasks completed results suggested that those who used this strategy the most actually benefited from it the least. Knight, Alderman and Burgess (2002) examined the same strategy (asking for help) and four others: looking at the map, reading signs, planning before start of task, and multitasking. Controls looked at the map and signs, and multitasked
significantly more than the brain injured participants. There was also a non-significant
tendency for controls to ask for help less often and plan for longer before starting the task.
For controls, multitasking was negatively correlated with the number of interpretation
failures (i.e., when failure was due to misunderstanding the task requirements), and for
patients, looking at signs was negatively correlated with the number of task failures. These
results suggest that controls benefited from planning at the start of the task and were able to
multitask without compromising task performance while patients benefited from the use of
signs during task completion.

Recently, a virtual shopping mall MET (Rand et al., 2008) was created and tested on
adults with stroke as well as young and old healthy controls. Instead of counting the
strategies used, they reported the number of “use of strategies mistakes”, that is not using a
strategy (e.g., not marking items that were bought) or using it inefficiently (e.g., marked only
some of the items they bought thereby causing confusion later). Participants in the post-
stroke group made significantly more strategy use mistakes than the older healthy controls
during completion of the virtual MET. The groups did not differ significantly on this
measure during completion of the regular shopping mall MET, which had also been
administered. Since the VMET takes place in a virtual environment and not in the real-
world, this difference in strategy use mistakes may be reflecting difficulty adapting to the
virtual environment for the stroke participants.

In summary, people with damage to the prefrontal lobes were found to perform more
poorly, use strategies inappropriately or inefficiently, or make more strategy use mistakes on
strategy application tasks designed to simulate real-world situations (Colvin et al., 2001;
Goel et al., 1997; Levine et al., 1998; Rand et al., 2009; Tranel et al., 2007). The regular
MET is administered in a real-world environment and gives participants tasks to perform
which they are likely to encounter in their day-to-day lives. This allows naturalistic strategy
use to be analyzed in the real world. All of the previous MET studies that incorporated the
quantification of the request for help strategy indicate that this strategy is used by participants
in the ABI groups more so than their controls (Alderman et al., 2003; Dawson et al.,
accepted; Knight et al., 2002). A few additional strategies were quantified by Knight and
colleagues (2002) and not only were there differences between ABI participants and controls
but strategy use was also related to MET performance differently between the two groups.
Nevertheless, naturalistic strategy selection and use in the ABI population has not been extensively studied. As reviewed above, results from previous research indicate that valuable information about a patient can be derived from analyzing their strategizing abilities. Further research on this matter is needed in order to develop strategy analysis tools that can be used to better understand naturalistic strategy use and how this valuable information can be applied to the patient’s advantage during rehabilitation. This thesis is the first to address this need through theory-based investigation of strategy use and the use of a real-world environment (i.e., the MET).

The Importance of Strategy Research for Cognitive Rehabilitation

As defined in the above section, the use of appropriate strategies supports successful task performance. However, results from the literature reviewed in the previous section indicate that ABI patients are sometimes unable to automatically apply appropriate strategies and that when they do, they are often not effective. These strategy application impairments pose a barrier in cognitive rehabilitation, yet the assessment methods traditionally employed are not designed to evaluate these impairments (Levine et al., 1998). In addition, patients with strategy application deficits are a very heterogeneous group; different patterns of symptoms are seen when comparing between patients or when comparing a patient’s performance one day to their performance on the same task another day (Levine et al., 2008). Decreased self-awareness and discrepancies between laboratory performance and real-world performance are also challenges when choosing cognitive rehabilitation interventions for this population.

An ecologically valid strategy assessment procedure developed for use with the MET would help identify which strategy use processes are deficient in a patient and would be a step towards overcoming these barriers. Instead of measuring a patient’s errors during assessment, this tool would provide information about a patient’s strategizing ability. Knowing which strategies people employ automatically even if they are not useful would be valuable to clinicians. With this information, clinicians could encourage their clients to continue using strategies that they are already using effectively, explore why other strategies are not being used or are used ineffectively, and determine how to remediate this ineffective strategy use. Therefore, this assessment would lead to clinicians being better informed about their patients’ rehabilitation needs, as well as their cognitive strengths and weaknesses. As a
result, we hypothesize that with this information clinicians would be able to choose the best forms of cognitive rehabilitation interventions and tailor rehabilitative programs to their patients. This research also has value for rehabilitation beyond use with the MET as it is an early step in trying to understand and differentiate between people with ABI and controls in relation to the type, frequency, and implementation of strategies while they are trying to accomplish a task. These findings will help lead the development of individualized and targeted forms of rehabilitation in clinical populations.
CHAPTER 3: Acquired brain injury and naturalistic strategy use: Analysis of strategies used during completion of the Multiple Errands Test

(In preparation for submission to the Journal of the International Neuropsychological Society)

Abstract

The purpose of this study was to improve our understanding of naturalistic strategy use in survivors of acquired brain injury (ABI) with executive dysfunction. A strategy scoring procedure derived from Stuss and colleagues’ theory on the fractionation of the prefrontal lobes was developed for the Baycrest Multiple Errands Test (BMET). Strategy use on the BMET was compared between 14 stroke survivors, 12 traumatic brain injury (TBI) survivors and their respective group of healthy age and education matched control participants. A few significant quantitative group differences based on frequency and proportion of strategy use were found along with significant relationships (rs=.30-.71) between strategy use and BMET performance within the groups indicating the importance of strategy use on performance of tasks of everyday life. Strategy use in the stroke group was positively related to performance while negative correlations were mostly found in the TBI group. These differences between ABI groups indicate that future research should account for etiology and lesion location. Results support and re-inform the task setting and monitoring processes from Stuss’ prefrontal lobe theory and demonstrate the importance of studying naturalistic strategy use for the improvement of cognitive rehabilitation post-ABI.

Introduction

There are significant efforts to develop theoretically sound and experimentally valid methods of cognitive rehabilitation for those who have acquired brain injury. Several obstacles have hampered many of these initiatives. Groups who are studied have acquired brain injury (ABI), without attention to differences in etiology or severity. The rationale for this approach is not clear, and the heterogeneity of etiologies may result in group variability. Theoretically, there has been an increasing and appropriate emphasis on “executive dysfunction” and inappropriate or absent use of strategies to overcome their problems
(Cicerone et al., 2000 and 2005 for reviews; Fox et al., 1989; von Cramen et al., 1991). Amongst these studies emphasizing the impact of “executive dysfunction”, the term is used generically, and the underlying processes not analyzed. Since these processes are related to different anatomical regions, the approaches may need to be different depending on location of pathology.

In this study we also focused on strategy use in order to further our understanding of how ABI survivors with executive dysfunction naturally employ strategies when completing tasks in a real-world environment. We compared two different etiologies of ABI (stroke and traumatic brain injury). We developed a theory-based strategy scoring procedure using Stuss’ theory on the fractionation of the prefrontal lobes and quantified the strategies used by ABI participants and healthy controls during completion of tasks on a naturalistic assessment of executive function, the Baycrest Multiple Errands Test (BMET).

Strategies are elements of behaviour which add to the effectiveness and efficiency of a person’s performance (Toglia, 2003). Properly selecting an appropriate strategy for the situation at hand can help move a person towards their goal (Toglia, 1991). When first learning a new strategy, the user intentionally selects it and remains aware of this choice; with time this strategy becomes automated, but can be consciously controlled if desired (Pressley et al., 1990). Strategy selection varies among individuals due to the diverse range of potential strategies that can yield the same end result (Pressley et al., 1990). This highly complex and diverse nature of strategy selection and use contributes to the difficulty associated with the study of naturalistic strategy use.

Previous research has alluded to the importance of better understanding naturalistic strategy use in the ABI population and to what this understanding could bring to the field of cognitive rehabilitation. Much of this body of research has focused on participants with damage to the prefrontal lobes (Colvin et al., 2001; Goel, Grafman, Tajik, Gana, & Danto, 1997; Levine et al., 1998; Tranel, Hathaway-Neppele, & Anderson, 2007). This brain area is involved with executive functions necessary for appropriate goal achievement and purposeful functioning in everyday, real-world situations (Barbas & Zikopoulos, 2007; Cicerone et al., 2005; Huey et al., 2006; Stuss, 1992; Stuss & Gow, 1992; Zalla et al., 2001). A person’s level of ability with these executive functions will ultimately impact their capacity to select and use appropriate strategies in their daily lives. In addition, a person’s performance on the
same task of executive function can vary from one time to the next as they adopt or learn more effective strategies and participants with prefrontal lobe injuries are prone to this variability in performance (Stuss, 1991).

The naturalistic nature of the Multiple Errands Test (MET) offers a good avenue to further study spontaneous strategy use in ABI survivors with executive dysfunction. The MET is a naturalistic assessment of executive functioning which requires participants to complete everyday tasks (e.g., purchase a greeting card, find out the closing time of a shop) in a real-world setting within the constraint of a set of rules. Performance analyses on the Baycrest version of the MET (BMET) have previously been conducted for the same sample used in this study (Dawson et al., accepted). Results indicated that participants in the stroke group completed fewer tasks, committed more total errors, and had more rule breaks than their control participants. Weighted task error scores were calculated separately for stroke participants and their controls and for TBI participants and their controls by giving each error a score of 1 (errors made by up to 95% of controls), 2 (made by less than 5% of controls), or 3 (errors made by brain injured participants but not seen in controls). Results indicated that the TBI group had significantly more weighted task errors than their control participants. Several other scores indicated a trend towards worse performance for those in the ABI groups and although not statistically different from their controls, moderate to large effect sizes (Cohen $d = 0.54 – 0.98$) were found. Dawson et al. also looked at the reliability and ecological validity of the BMET. Intra-class correlations of .71 or higher between raters on all the BMET scores indicated excellent inter-rater reliability, while moderate to high correlations between BMET scores and measures of daily life ability and participation suggested good ecological validity. As a whole, the BMET was found to discriminate reasonably well between ABI participants and their controls with excellent inter-rater reliability and ecological validity.

Previous research with the MET has also suggested that selection and use of strategies in ABI participants differs from that of the normal population (Alderman et al., 2003; Dawson et al., 2005; Dawson et al., accepted; Knight et al., 2002; Rand et al., 2008; Shallice & Burgess, 1991; Tranel et al., 2007). Use of the “requesting help” strategy was quantified in many previous MET studies (Alderman et al., 2003; Dawson et al., 2005; Dawson et al.,
accepted; Knight et al., 2002) and results indicated that ABI participants used this strategy more often than healthy controls. Knight and colleagues (2002) analyzed additional strategies used during MET completion. Controls looked at the map and signs, and multitasked significantly more than the brain injured participants. There was also a non-significant tendency for controls to ask for help less often and plan for longer before starting the task. For controls, multitasking (i.e., pursuing two or more tasks simultaneously) was negatively correlated with the number of interpretation failures while for patients looking at signs was negatively correlated with the number of task failures. However, it should be pointed out that the control participants in their study were employees of the hospital; as such, asking for help was likely needed only for newer employees of that hospital.

In summary, previous research has recognized the importance of understanding naturalistic strategy use, but how do we go about studying strategy use? We argue that a fruitful approach is through the application of frontal lobe theory, which to our knowledge has not previously been done. There is evidence that the prefrontal lobes’ supervisory system (from the Supervisory Attention System as proposed by Norman & Shallice in 1986) can be fractionated; that different regions of the prefrontal lobes support different processes (Alexander, 2006; Alexander et al., 2007; Picton et al., 2006; Picton et al., 2007; Shallice, 2002; Stuss & Alexander, 2007; Stuss, 2006; Stuss et al., 1995; Stuss et al., 2002). Stuss and his colleagues postulate that there are four categories of prefrontal lobe function: energization, behavioural self-regulation, metacognition, and executive. The frontal processes of particular interest here were those associated with executive functioning, namely task setting, associated with the left lateral frontal lobe and task monitoring associated with the right lateral frontal lobe (Stuss et al., 2002; Stuss & Alexander, 2007). Stuss and Alexander (2007) defined task setting “as the ability to set a stimulus-response relationship” and task monitoring as “the process of checking the task over time for ‘quality control’ and the adjustment of behaviour”. These two processes interact with other frontal and posterior processes as required, such as during the selection and use of appropriate strategies for goal-achievement, which was studied here (Stuss & Alexander, 2007).

The main purpose of this study was to further our understanding of how ABI survivors with executive dysfunction naturally employ strategies as they attempt to complete tasks and how these strategies move them towards their goal or impede progress. Strategies used
naturally during the completion of a naturalistic, real-world assessment, the Baycrest-
Multiple Errands Test (BMET), were analyzed within the context of the theory of the 
fractionation of the prefrontal lobes. More specifically, the aim of this exploratory study was 
to specify the full range of strategies used by ABI participants and healthy controls during 
BMET completion.

Our objectives were to:
1) Determine if and how strategy use by the stroke and TBI participants was related to 
performance on the BMET and how this compared to relationships between strategic 
behaviour and performance as seen in control participants;
2) Investigate whether the proportion of participants who used each strategy and the 
frequency of use of each strategy differed between ABI cases and their controls;
3) Examine these relationships and differences within the context of the theory on the 
fractionation of the prefrontal lobes in order to observe how this theory might inform future 
research on naturalistic strategy use and the rehabilitation of adult ABI survivors with 
executive dysfunction.

Materials and Methods

Participants
Fifty-one community dwelling participants took part in the study; 26 ABI survivors and 25 
controls. Of those with an ABI, 14 were stroke survivors and 12 had suffered a TBI. They 
were recruited through local ABI agencies and from a list of previous participants who had 
given prior consent for future studies. ABI participants were required to be a minimum of 3 
months post-injury and at least 18 years of age or older. They had to be able to read, 
understand and speak English and walk independently for at least half an hour. During the 
Baycrest telephone screening process, the Centre for Epidemiological Studies Depression 
scale (CES-D) was administered and participants had to score below the cut-off of 16 to be 
eligible for this study.

The other 25 participants made up the control groups (13 stroke controls and 12 TBI 
controls). They were recruited individually from the Baycrest volunteer pool and from 
friends and family of the participants to match for age (±5 years), gender, and education (±5 
years). They were required to meet the same inclusion criteria as the participants in the ABI
group (with the exception of the post-injury factor) and have a Mini-Mental Status Examination (MMSE) score within 1.5 standard deviations from the norm for their age and degree of education.

Sociodemographic data were collected (Table 3.1) and all of the participants underwent a neuropsychological evaluation to measure attention, memory, executive functioning, visuo-perception and visuo-constructional abilities. Controls were required to be within 2 standard deviations from the norm on these tests to ensure their control group status (for more details on the results of the neuropsychological evaluation see Dawson et al., accepted).

### Table 3.1 Participant Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Stroke (n=14)</th>
<th>Stroke Controls (n=13)</th>
<th>TBI (n=12)</th>
<th>TBI Controls (n=12)</th>
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<tbody>
<tr>
<td>Age Mean ± SD (Range)</td>
<td>59.0 ± 14.2  (33 – 80)</td>
<td>56.7 ± 15.8  (27 – 81)</td>
<td>43.4 ± 9.7  (26 – 58)</td>
<td>46.1 ± 9.6  (22 – 57)</td>
</tr>
<tr>
<td>Education Mean ± SD (Range)</td>
<td>15.1 ± 3.3  (7 – 19)</td>
<td>15.6 ± 3.4  (10 – 23)</td>
<td>15.7 ± 3.5 (11 – 22)</td>
<td>15.8 ± 3.0 (12 – 21)</td>
</tr>
<tr>
<td>Number Males : Females</td>
<td>8 : 6</td>
<td>7 : 6</td>
<td>10 : 2</td>
<td>10 : 2</td>
</tr>
<tr>
<td>Years post -ABI ± SD (Range)</td>
<td>8.6 ± 6.0  (0.4 – 19.0)</td>
<td>n/a</td>
<td>11.7 ± 8.1 (0.6 – 26.9)</td>
<td>n/a</td>
</tr>
</tbody>
</table>

All of the participants provided written informed consent to take part in the study. The study was conducted in accordance to human ethics standards and received ethics approval from the joint Baycrest Centre/University of Toronto Scientific and Ethics Review Committee.

**The BMET and Testing Environment**

All of the research participants completed the Baycrest version of the Multiple Errands Test (BMET) designed to be administered at the Baycrest Centre in Toronto, Ontario, Canada. Like the earlier MET versions, the BMET is comprised of 12 everyday-type tasks that must be completed within the constraint of 8 rules. These tasks include buying and collecting specific items, using the telephone, mailing something, gathering 4 pieces of specific information, meeting the examiner on time at a designated meeting spot and telling the examiner when they have completed the test. Its development is detailed in Dawson et al., accepted.

The test required participants to use many of the services available on the first floor of the hospital such as the gift shop, cafeteria and library, in order to successfully complete all 12 tasks. An administration manual providing explicit instructions for the examiner was used to
ensure that the administration process remained consistent for all the participants and that none were inadvertently provided with cues. The administration took approximately one hour and included a pre-test section which involved going over the list of tasks and rules to ensure that participants understood what they were required to do before starting. The participants were given the task sheet/rule list and map of the first floor of the Baycrest Centre (see Appendix D) on a clipboard with a pen. Along with these items, participants received a messenger bag, which they could use to store items purchased or collected and a ten dollar bill which was to be used to purchase items as required for the tasks. The participants’ performance as they attempted to complete all 12 tasks within the constraints of the set of rules was videotaped and scripted. The BMET videotapes and scripts were used for strategy scoring.

**Development of the strategy score sheet**

The initial strategy score sheet contained a list of strategies developed a priori by the authors who were familiar with the BMET. Inter-rater reliability of the initial strategy score sheet was high for strategies observed (Cronbach’s alpha = .97) and frequency of strategy use (Cronbach’s alpha = .96). Through observation of performance on the BMET videotapes and analyses of tasks, the authors identified additional strategies which were then added to the list to allow for the analysis of the full range of strategies used during BMET completion. Next, the definitions of task setting and monitoring (Stuss & Alexander, 2007) were applied to the strategy list to divide it into two categories; task setting strategies (e.g., planning) and task monitoring strategies (e.g., marking a task as complete on the task sheet). Self-talk and request for help strategies could be used for either task setting or monitoring. For example, one participant said to himself “I’m gonna mail this” when setting the mailing task while another exclaimed “Oh geez!” when he monitored his behaviour and realized he was walking in the wrong direction. Another participant asked a staff member how to get to the gift shop since that is where he needed to be to complete his next task (task setting request for help) and on the way there he asked a second staff member if he was still going in the right direction to reach the gift shop (task monitoring request for help). Therefore, self-talk and requests for help were scored as either task setting or monitoring depending on the context. The final score sheet, including the task setting and monitoring strategy classification is
provided in Appendix E. Inter-rater reliability for the revised score sheet was not examined as a part of this exploratory study.

**Strategy Scoring Procedure**

The 51 BMET videotapes were viewed and scored on the strategy use score sheet (Appendix E) by first author (MA). The BMET scripts were also reviewed to ensure that all strategies were included. The scripts provided additional and complementary information in situations where the cameraperson could not get close enough to the participant to capture everything that was being said or done (e.g., participant was in a crowded or noisy situation). Each strategy was accompanied by an observed score of 1 if it had been observed or 0 if it had not. Each strategy that had been observed was then accompanied by a frequency score indicating the number of times it had been employed while strategies that were not used by that participant had a frequency score of zero. The total number of strategies observed and total frequency scores were also computed for each participant. One additional participant with TBI was excluded due to a severe energization deficit (i.e., problems initiating and sustaining any response, Stuss & Alexander, 2007) causing him to initiate the use of very few strategies independently. Therefore, of the original 13 participants in the TBI group, only 12 were included in the analysis.

**Planned Analyses**

The participants in the stroke and TBI groups were compared to their respective control groups to ascertain how performance on the BMET was related to strategic behaviour. The total number of tasks completed accurately out of 12 was used as a measure of BMET performance. Its relationship to the frequency of strategy use for each individual strategy as well as total strategies observed and total frequency was analyzed using Spearman correlations. Data were analyzed using non-parametric statistics due to violations of the normal distribution assumption. Correlations that were moderate ($r_s = .30$) or stronger were considered favourable (Norman & Streiner, 2008). Every strategy was used in the analyses due to the exploratory nature of designing a naturalistic strategy score sheet. The results from these multiple comparisons are considered in this light.

Group differences in the proportion of participants that used each strategy and the frequency of use of each strategy for each group were explored using Chi-squared analyses.
Effect sizes for chi-square analyses ($r$) were determined by calculating the phi/phimax ratio (Norman & Streiner, 2008). The Mann-Whitney U test, used to compare group medians when the two distributions are the same, was applied to determine if frequencies of strategy use differed between cases and their controls. For the strategy “physically oriented self to map or map to self” the two distributions were not the same for the stroke group and their controls, meaning that the Mann-Whitney U was used as a test of mean ranks in this situation. Effect sizes for the Mann-Whitney U ($r$) were calculated by dividing the $z$ scores obtained by the square root of $N$ (Field, 2009).

**Results**

The results are presented according to our three main areas of focus. We first examined task setting and monitoring strategy use and their relationship to performance on the BMET to determine how the groups used strategies to complete the tasks. Our results indicated that the groups differed in pattern of relationships between strategy use and performance. We then compared the proportions of people using each strategy and the frequency of use for each strategy between the ABI groups and their respective control groups.

**Relationship between strategy use and BMET performance**

The relationship between performance on the BMET and the frequency of strategy use for each individual strategy as well as total strategies observed and total frequency was analyzed using Spearman correlations. Moderate ($r = .30$) and stronger correlations are shown in Table 3.2 (smaller correlations were omitted for clarity but can be seen in Appendix F). Strategies in the table are grouped into task setting and task monitoring as defined earlier and shown in Appendix E.

It is immediately noticeable that despite some similarities, relationships between strategy use and performance were overall different for the stroke and the TBI groups; some of the strategies were related to performance for only one of the ABI groups while others were related to performance in both of the ABI groups but in opposing directions. Therefore, the two ABI groups were not analyzed together but instead considered separately and compared to their respective control groups for all analyses.
Table 3.2 Relationships† between strategy use and BMET performance‡

<table>
<thead>
<tr>
<th>Strategies</th>
<th>Stroke n=14</th>
<th>Stroke Control n=13</th>
<th>TBI n=12</th>
<th>TBI Control n=12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total frequency of strategies used</td>
<td>-.71*</td>
<td>.41</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Task Setting Strategies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planned before starting test</td>
<td>.32</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time spent planning (in seconds)</td>
<td>.36</td>
<td>.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Read task sheet/rule list &gt;5 seconds</td>
<td>.53</td>
<td>.53</td>
<td></td>
<td>.54</td>
</tr>
<tr>
<td>Read map &gt;5 seconds</td>
<td>.31</td>
<td></td>
<td>.52</td>
<td>.52</td>
</tr>
<tr>
<td>Made notes (other than those required)</td>
<td>.52</td>
<td>.52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task setting type self-talk</td>
<td>-.52</td>
<td>-.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Checked watch at start of task</td>
<td>.46</td>
<td>.42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Looked at candy rack for price of Mars bar</td>
<td>.48</td>
<td>.48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asked examiner questions prior to start point</td>
<td>.45</td>
<td>-.44</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Task Monitoring Strategies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Checked task sheet/rule list</td>
<td>-.43</td>
<td></td>
<td>.30</td>
<td></td>
</tr>
<tr>
<td>Checked map</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marked task as complete</td>
<td>.34</td>
<td>.30</td>
<td>-.38</td>
<td>.54</td>
</tr>
<tr>
<td>Checked watch (first 10 mins)</td>
<td>.30</td>
<td>.38</td>
<td>.45</td>
<td>.35</td>
</tr>
<tr>
<td>Looked at signage and visual landmarks</td>
<td>-.40</td>
<td>-.71*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monitoring type self-talk</td>
<td>-.46</td>
<td>-.37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monitoring type requests for help from staff</td>
<td>-.56</td>
<td>-.35</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

† Two-tailed Spearman correlations were used to determine the relationships. (Correlations <.30 were not included for clarity.)
‡ the number of tasks completed accurately out of a possible 12 was used as the measure of BMET performance.
* p < .05

In the stroke group (Table 3.2), strategy use was positively related with the number of tasks completed accurately, showing that a higher frequency of use of those particular strategies was associated with better performance on the BMET. The exception was that the use of the “looked at signage and visual landmarks” strategy was negatively ($r_s = -.40$) associated with BMET performance. Positive correlations between many strategies (Table 3.2) and performance on the BMET were also found for the stroke control group, again with one exception; a negative relationship of $- .44$ between performance and “asked examiner questions prior to start point”.

The correlations between performance and the total frequency scores show that, primarily, a higher frequency of strategy use was associated with fewer tasks completed accurately for the TBI group while the correlation was in the opposite direction for their controls (Table 3.2). For a few strategies, frequency of use was positively related to performance in the TBI group. Interestingly, these strategies tended to be of the task setting type; planning ($r_s = .32$) and checking watch ($r_s = .42$) at start of task. The only task setting...
strategy negatively correlated with performance for the TBI group was task setting self-talk ($r_s = -.52$), however, this was also seen in the TBI controls ($r_s = -.32$) and again in both groups for the monitoring type self-talk ($r_s = -.46$, TBI; $r_s = -.37$, controls), suggesting that the use of self-talk as a strategy was as a whole not beneficial to performance. The negative correlations in the TBI group were mostly seen with the monitoring strategies, with the exception of checking their watch during the first 10 minutes of the task, which was positively correlated ($r_s = .45$) with performance. In the TBI control group, most of the strategies showed a positive correlation between frequency of use and performance. The only exceptions were use of self-talk, as mentioned earlier, and use of monitoring type requests for help, which again was negatively correlated in both the groups ($r_s = -.56$, TBI group; $r_s = -.35$, control group).

**Comparisons of strategy use proportions**

Table 3.3 shows the number of participants per group who used each strategy. Chi-squared analyses were conducted to determine differences between cases and their controls. Overall the number of participants per group that used each strategy was similar, as can be seen from the results of the chi-squared analyses (Table 3.3).
Table 3.3 Number of participants per group using each strategy†

<table>
<thead>
<tr>
<th>Task Setting Strategies</th>
<th>Stroke controls n = 14</th>
<th>Stroke controls n = 13</th>
<th>p</th>
<th>r</th>
<th>TBI controls n = 12</th>
<th>TBI controls n = 12</th>
<th>p</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planned before starting test</td>
<td>10</td>
<td>8</td>
<td>9</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Read task sheet/rule list &gt;5 seconds</td>
<td>14</td>
<td>13</td>
<td>12</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Read map &gt;5 seconds</td>
<td>9</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physically oriented self to map or map to self</td>
<td>0</td>
<td>3</td>
<td>0.10</td>
<td>0.37</td>
<td></td>
<td>4</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Drew route during task</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Made notes (other than those required)</td>
<td>9</td>
<td>4</td>
<td>0.13</td>
<td>0.36</td>
<td></td>
<td>6</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Task setting type self-talk</td>
<td>11</td>
<td>11</td>
<td>7</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Checked watch at start of task</td>
<td>3</td>
<td>5</td>
<td>2</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organized materials and bag</td>
<td>4</td>
<td>1</td>
<td>0.33</td>
<td>0.58</td>
<td></td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Went to meeting spot early and waited for examiner</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Got money ready while in line or entering store/cafe</td>
<td>7</td>
<td>10</td>
<td>0.24</td>
<td>0.38</td>
<td></td>
<td>7</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Went straight to 99c cent card rack</td>
<td>4</td>
<td>10</td>
<td>0.02</td>
<td>0.52</td>
<td></td>
<td>7</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Checked/compared price of card before buying</td>
<td>6</td>
<td>0</td>
<td>0.02</td>
<td>0.52</td>
<td></td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Looked at candy rack for price of Mars bar</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asked examiner questions prior to start point</td>
<td>7</td>
<td>4</td>
<td>1</td>
<td>7</td>
<td></td>
<td></td>
<td>0.03</td>
<td>0.75</td>
</tr>
<tr>
<td>Asked examiner questions at start point</td>
<td>10</td>
<td>9</td>
<td>4</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task setting type requests for help from staff</td>
<td>14</td>
<td>12</td>
<td>12</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multitasked</td>
<td>13</td>
<td>13</td>
<td>11</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Monitoring Strategies</th>
<th>Stroke controls n = 14</th>
<th>Stroke controls n = 13</th>
<th>p</th>
<th>r</th>
<th>TBI controls n = 12</th>
<th>TBI controls n = 12</th>
<th>p</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check task sheet/rule list</td>
<td>14</td>
<td>13</td>
<td>12</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check map</td>
<td>9</td>
<td>11</td>
<td>9</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marked task as complete</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monitoring type self-talk</td>
<td>9</td>
<td>11</td>
<td>7</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Checked watch (first 10 mins)</td>
<td>5</td>
<td>6</td>
<td>4</td>
<td>8</td>
<td></td>
<td></td>
<td>0.22</td>
<td>0.33</td>
</tr>
<tr>
<td>Monitored spending</td>
<td>5</td>
<td>2</td>
<td>0.39</td>
<td>0.40</td>
<td></td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Looked overtly at signage and visual landmarks</td>
<td>13</td>
<td>13</td>
<td>11</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monitoring type requests for help from staff</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

†Chi-squared analyses were conducted to compare the proportions. Comparisons are between the stroke group and their controls, and between the TBI group and their controls. For clarity, only findings significant at the .05 level or with effect sizes > .30 are shown (r = effect size, determined via phi/phimax ratio (Norman & Streiner, 2008).

Significant differences between stroke participants and their controls were found with the strategies involved in the task of buying a birthday card. Significantly more stroke controls went directly to the 99 cent card rack to purchase a card than did stroke participants [$\chi^2(1) = 6.31$, $p = 0.02$, $r = 0.52$]. The use of this strategy is efficient because participants can then buy any of the cards on the sale rack knowing that the cost of each is only 99 cents. This allowed the participants who used this strategy to stay within the $7.50 spending limit without unnecessary time investment in price comparison among many cards. On the other hand, significantly more stroke participants went to the regular priced card rack and checked the price of the card or compared prices between many cards to ensure that they stayed within their spending limit [$\chi^2(1) = 7.16$, $p = 0.02$, $r = 0.52$].

There was also a trend towards a difference between the proportion of participants in the stroke group (0/14) and the control group (3/13) who used the strategy of physically orientating the self to map or the map to self [$\chi^2(1) = 3.64$, $p = 0.10$]. Although not
statistically significant at $p<.05$, this trend was associated with a clinically important effect size of .37.

Significantly more people in the TBI control group asked the examiner questions prior to start point $[\chi^2(1) = 6.75, p = 0.03, r = 0.75]$. In fact only one TBI participant used this strategy. In addition, only 4 people in the TBI group checked their watch during the first 10 minutes of the test while double the number of control participants did so. Although this difference was not significant $[\chi^2(1) = 2.67, p = 0.22]$, there was a small effect size of .33 worth consideration.

**Comparisons of strategy use frequencies**

Table 3.4 illustrates the frequency of strategy use by all four participant groups. To analyze differences between the usage frequencies for each strategy, the Mann-Whitney U test was applied. Table 3.4 displays the group medians along with the $p$ values and effect sizes ($r$) for all of the strategies with the exception of “physically oriented self to map or map to self” in the stroke group and their controls for which the mean rank is reported due to the differences between these two distributions. Interestingly, although strategy use was related to performance differently for stroke participants and their controls, frequency of use was overall similar between the two groups.
Table 3.4 Comparisons between medians† for ABI participants and their respective controls

<table>
<thead>
<tr>
<th>Strategies</th>
<th>Stroke</th>
<th>Stroke</th>
<th>p</th>
<th>r</th>
<th>TBI</th>
<th>TBI</th>
<th>p</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=14</td>
<td>n=13</td>
<td></td>
<td></td>
<td>n=12</td>
<td>n=12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total strategies observed</td>
<td>15.5</td>
<td>16.0</td>
<td>0.98</td>
<td>0.01</td>
<td>14.5</td>
<td>14.5</td>
<td>0.89</td>
<td>0.03</td>
</tr>
<tr>
<td>Total frequency of strategies used</td>
<td>93.0</td>
<td>89.0</td>
<td>0.72</td>
<td>0.07</td>
<td>94.0</td>
<td>98.0</td>
<td>0.29</td>
<td>0.22</td>
</tr>
<tr>
<td><strong>Task Setting Strategies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time spent planning (in seconds)</td>
<td>41.5</td>
<td>34.0</td>
<td>0.38</td>
<td>0.01</td>
<td>19.5</td>
<td>11.0</td>
<td>0.70</td>
<td>0.08</td>
</tr>
<tr>
<td>Read task sheet/rule list &gt;5 seconds</td>
<td>14.0</td>
<td>15.0</td>
<td>0.94</td>
<td>0.01</td>
<td>12.0</td>
<td>13.5</td>
<td>0.40</td>
<td>0.17</td>
</tr>
<tr>
<td>Read map &gt;5 seconds</td>
<td>2.5</td>
<td>4.0</td>
<td>0.49</td>
<td>0.14</td>
<td>5.0</td>
<td>7.5</td>
<td>0.58</td>
<td>0.11</td>
</tr>
<tr>
<td>Physically oriented self to map or map to self</td>
<td>12.5‡</td>
<td>15.6‡</td>
<td>0.33</td>
<td>0.36</td>
<td>0.0</td>
<td>1.0</td>
<td>0.18</td>
<td>0.27</td>
</tr>
<tr>
<td>Made notes (other than those required)</td>
<td>2.0</td>
<td>0.0</td>
<td>0.20</td>
<td>0.27</td>
<td>0.5</td>
<td>0.0</td>
<td>0.90</td>
<td>0.03</td>
</tr>
<tr>
<td>Task setting type self-talk</td>
<td>1.5</td>
<td>1.0</td>
<td>0.92</td>
<td>0.02</td>
<td>1.5</td>
<td>0.0</td>
<td>0.25</td>
<td>0.23</td>
</tr>
<tr>
<td>Organized materials in bag</td>
<td>0.0</td>
<td>0.0</td>
<td>0.16</td>
<td>0.27</td>
<td>0.0</td>
<td>0.0</td>
<td>0.51</td>
<td>0.13</td>
</tr>
<tr>
<td>Asked examiner questions prior to start point</td>
<td>0.5</td>
<td>0.0</td>
<td>0.69</td>
<td>0.08</td>
<td>0.0</td>
<td>1.0</td>
<td>0.05*</td>
<td>0.41</td>
</tr>
<tr>
<td>Asked examiner questions at start point</td>
<td>1.0</td>
<td>1.0</td>
<td>0.57</td>
<td>0.11</td>
<td>0.0</td>
<td>0.0</td>
<td>0.76</td>
<td>0.06</td>
</tr>
<tr>
<td>Task setting type requests for help from staff</td>
<td>9.5</td>
<td>4.0</td>
<td>0.03*</td>
<td>0.41</td>
<td>6.0</td>
<td>4.5</td>
<td>0.66</td>
<td>0.09</td>
</tr>
<tr>
<td><strong>Task Monitoring Strategies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Checked task sheet/rule list</td>
<td>20.0</td>
<td>17.0</td>
<td>0.96</td>
<td>0.17</td>
<td>20.0</td>
<td>22.5</td>
<td>0.49</td>
<td>0.14</td>
</tr>
<tr>
<td>Checked map</td>
<td>1.5</td>
<td>7.0</td>
<td>0.04*</td>
<td>0.39</td>
<td>4.0</td>
<td>11.0</td>
<td>0.09</td>
<td>0.35</td>
</tr>
<tr>
<td>Marked task as complete</td>
<td>4.0</td>
<td>3.0</td>
<td>0.55</td>
<td>0.12</td>
<td>3.5</td>
<td>3.0</td>
<td>0.29</td>
<td>0.22</td>
</tr>
<tr>
<td>Monitoring type self-talk</td>
<td>1.0</td>
<td>1.0</td>
<td>0.52</td>
<td>0.12</td>
<td>1.0</td>
<td>1.0</td>
<td>0.83</td>
<td>0.04</td>
</tr>
<tr>
<td>Checked watch (first 10 mins)</td>
<td>0.0</td>
<td>0.0</td>
<td>0.31</td>
<td>0.19</td>
<td>0.0</td>
<td>1.0</td>
<td>0.07</td>
<td>0.37</td>
</tr>
<tr>
<td>Monitored spending</td>
<td>0.0</td>
<td>0.0</td>
<td>0.33</td>
<td>0.19</td>
<td>0.0</td>
<td>0.0</td>
<td>0.95</td>
<td>0.01</td>
</tr>
<tr>
<td>Looked at signage and visual landmarks</td>
<td>7.0</td>
<td>6.0</td>
<td>0.35</td>
<td>0.18</td>
<td>5.5</td>
<td>7.5</td>
<td>0.09</td>
<td>0.34</td>
</tr>
<tr>
<td>Monitoring type requests for help from staff</td>
<td>0.0</td>
<td>0.0</td>
<td>0.40</td>
<td>0.16</td>
<td>0.0</td>
<td>0.0</td>
<td>0.97</td>
<td>0.01</td>
</tr>
</tbody>
</table>

† Unless otherwise noted, group medians are reported.
‡ Mean ranks are reported here because the two distributions were not the same, making the Mann-Whitney U a test of mean ranks in this case.

* significant at the p < .05 level

Frequency of use for two of the strategies did show a significant difference between stroke participants and their controls. The median frequency of task setting type requests for help was 9.5 for the stroke participants. This was significantly higher than the median of 4 seen in the control group \[U_{(25)} = 47.00, z = -2.15, p = 0.03, r = 0.41\]. The difference is the opposite direction for the frequency of map checks, which was significantly lower in the stroke group (median = 1.5) in comparison to their controls (median = 7) \[U_{(25)} = 49.50, z = -2.04, p = 0.04, r = 0.39\].

There was a trend towards a difference in frequency of use of the physically orientating the self to map or the map to self strategy \[U_{(25)} = 70.00, z = -1.87, p = 0.33\] between strokes and their controls. Although not statistically significant at the p = .05 level, this finding did possess an effect size of .36.

TBI participants were less likely than their controls to ask the examiner questions prior to the start of the task \[U_{(22)} = 42.00, z = -2.00, p = 0.05, r = 0.41\]. Although no other
differences between these two groups were significant, a few others did have an effect size worth considering and were approaching significance. This includes the TBI control participants looking at their watch more frequently \[U(22) = 43.00, z = -1.81, p = 0.07, r = 0.37\] than TBI participants. This particular strategy is directly related to the completion of the parrot cage task. Participants who did not check their watch in the first 10 minutes would be less likely to make it to the parrot cage on time and complete this task accurately. Frequency of map checks \[U(22) = 42.50, z = -1.71, p = 0.09, r = 0.35\] where the median for the TBI group was 4 and the median for their controls was 11 and looking at signage and visual landmarks \[U(22) = 43.00, z = -1.68, p = 0.09, r = 0.34\] where the median for the TBI group was 5.5 and the median for their control group was 7.5 were also approaching significance.

**Further investigations of results**

The frequency of tasks marked as complete was positively correlated (table 3.2) with the number of tasks completed accurately for all of groups except for the TBI group, where a negative correlation was found \(r_s = -.38\). This opposite relationship for those in the TBI group was unexpected but further investigation revealed that this strategy was positively correlated \(r_s = .49\) with the number of partial task failures (tasks that were attempted but not completed accurately), indicating that partial task failures were incorrectly being marked as tasks completed accurately by participants in the TBI group.

The TBI group was also the only group to show a correlation between performance and frequency of task sheet checks. More importantly, this relationship was negative \(r_s = -.43\), suggesting that participants in this group who checked their task sheet more often actually had worse performance on the BMET. It was thought that working memory might be playing a role in this relationship. Therefore, a Spearman correlation was conducted between frequency of checking the task sheet/rule list and working memory. Scores on the Digit Span test, which had been administered as part of the neuropsychological assessment, were used as a measure of working memory. Digit Span requires participants to listen to a string of numbers which they must then repeat correctly. The string of numbers increases in length with each trial thereby increasing the amount of information to be held in working memory as the task progresses. A relationship in the expected direction was found for the TBI
controls ($r_s = -.69, p = .01$). However, no relationship between working memory and frequency of task sheet checks was found for the TBI group ($r_s = .11, p = .74$). This suggests that while control participants checked their task sheet at a frequency that was related to their ability, participants with TBI were not checking their task sheet in order to compensate for working memory deficits.

Similarly, looking at signage and landmarks was another strategy negatively related to performance, this time for both ABI participants groups, while no such relationship was found with their control groups. Spearman correlations between the measures of familiarity with Baycrest and frequency of looking at signage and landmarks were conducted to determine if these relationships were due to familiarity with the testing environment. A relationship between familiarity and signage use was present with controls ($r_s = -.33$ to $-.45$) but not with ABI participants ($r_s = -.01$ to $.21$), suggesting that controls who were more familiar with Baycrest relied less on signage and landmarks. ABI participants on the other hand used this strategy regardless of familiarity and, in turn, those who used it more frequently completed fewer tasks accurately.

**Discussion**

This study helps to elucidate the different strategies used by survivors of stroke and TBI in a real-world setting. Our results illustrated that the stroke and TBI groups had varied strategy use compared to their respective control groups, indicating that the study of naturalistic strategy use in these populations would provide beneficial information to the cognitive rehabilitation field. Between the two types of ABI participants (stroke & TBI), different patterns of strategy use emerged, leading to the hypothesis that future research should consider these two groups separately or divide the groups based on lesion location. Results of the study provide support to the theory on the fractionation of the prefrontal lobes. Each of these findings is discussed below.

**Differences between ABI groups**

Research on ABI participants often pools the results from individuals with various etiologies together (Alderman et al., 2003; Kaschel et al., 2002; Knight et al., 2002; Ownsworth, McFarland, & Young, 2000; Wilson et al., 1996). However, as is evident in the current results and in the errors and psychometric analyses on this sample (Dawson et al., accepted),
strategy use and performance on the BMET was not homogeneous between individuals with stroke and those with TBI. The strategies which correlated with performance in the stroke group were different than those which correlated with performance in the TBI group. Also, frequency of strategy use was overall positively correlated with performance for the stroke participants while the opposite was true for the TBI participants. TBI damage is often diffuse due to shifting and twisting of the brain upon impact while vascular damage is more likely to be focal (Levine et al., 2008) and this may have contributed to these differences. Since previous work has shown that location of damage is more important than the cause of injury in determining the resulting deficits (Elsass & Hartelius, 1985; Stuss et al., 2005), future research in this area should include the use of neuroimaging to better map lesion location to performance on the MET and strategy use.

The theory on the fractionation of the prefrontal lobe

We used Stuss and colleagues’ theory on the fractionation of the prefrontal lobes as the basis for strategy classification (for review, see Stuss & Alexander, 2007). More specifically, we divided the strategies into two types - task setting and monitoring - both of which are aspects of executive capacity. This separation identified the monitoring difficulties experienced by the TBI group through the negative correlations found between use of monitoring strategies and performance. If the groups were characterized based on lesion location as mentioned in the previous chapter we may have been able to identify which lesions were associated with task setting and monitoring problems. Few task setting strategies were correlated in the stroke group, perhaps grouping strategies would have allowed more correlations to emerge. Previously, Stuss and Alexander (2007) suggested that these definitions were still too broad and that they could be further fractionated. Our results are in agreement with this: if the definitions were further divided the strategies could be re-grouped into more specific constructs. For example, monitoring strategies could be related to the timing aspect of monitoring, such as watch checking, or to monitoring for errors, evident when participants checked the map to be sure they were still going the right way. This would allow the identification of which aspect of task setting or monitoring a participant is having difficulty with. Knowing this would allow for a more tailored strategy training plan to be developed and more effective rehabilitation for participants.
Stroke participants compared to their control group

Stroke participants and their controls generally benefited from strategy use as the frequencies of use of several strategies were positively correlated with the number of tasks completed. An exception for the stroke control group was the negative correlation between tasks completed accurately and the number of questions asked to the examiner prior to the start point. However, this does not necessarily indicate that this strategy was not a useful one because for participants in the stroke group, a higher frequency of use of this same strategy was related to more tasks completed accurately. This may mean that controls were not asking the examiner the right type of questions or that those who used this strategy were lower functioning and had not understood the task.

Frequency of use of three strategies differed between the stroke participants and their controls: the number of task setting type requests for help from staff and the number of map checks and physical orientation with the map. Although all of the stroke participants and their controls used the requesting help to task set strategy, those in the stroke group used it more frequently. This result is an extension of the results reported by Dawson et al. (accepted) regarding requests for help by the stroke participant and their controls. This is also in accordance with findings from previous MET studies where the ABI participants (mixed etiologies) used this strategy more often than controls (Alderman et al., 2003; Knight et al., 2002). As mentioned by Alderman (2003), the use of this strategy is exaggerated in ABI participants and they rely on this strategy more than their controls. On the other hand, when it came to checking the map and physical orientation, stroke participants did so less frequently compared to controls. Knight (2002) also found that the control group checked the map more often. The use of this strategy by healthy individuals is beneficial as it helps the navigational process. Previous research has shown that older adults have difficulty interpreting information on a map when it is not properly aligned with the environment (Aubrey, Li, & Dobbs, 1994). Since participants were given a map to carry with them, they had to physically orient themselves to the map, alter the map to themselves, or mentally rotate what they were seeing on the map in order to align it with their environment. This task is more difficult for older adults compared to younger adults (Aubrey et al., 1994), and such difficulties may be exacerbated by the cognitive deficits associated with stroke, thereby discouraging map use in this population.
A difference in proportions emerged in how participants with stroke and their controls went about the task of purchasing a birthday card. Since participants were only allowed to spend $7.50 to complete all of the tasks, the fastest and most efficient strategy to complete the birthday card task for the BMET (given the Baycrest environment) was to go straight to the 99 cent card rack and choose any of the birthday cards on that rack for purchase. This was in fact the strategy used by the majority of the stroke controls. However, very few stroke participants used this strategy. Instead, most went to the regular priced card rack and checked the price of the card or compared the price of several cards before choosing one to buy. This strategy is still a good one; it allowed them to complete the task without breaking any rules. However, the time required in this method was greater than that required for those who went to the 99 cent card rack. In fact, had there been no 99 cent card rack, it is expected that all of the controls would have used the check/compare price of card strategy. Some of the participants eventually were directed to the 99 cent card rack when they asked for a less expensive card and others noticed it and went to it after having first compared the price of several more expensive cards. Why more stroke participants did not go straight to the 99 cent card rack is unknown. It was located on the participants’ right, meaning that failure to notice it can not be explained by left-side neglect, which is common after right-hemispheric strokes (Buxbaum et al., 2007). However, the regular price card rack was closer to the entrance and came into view first; making it possible that once stroke participants noticed that rack they did not bother to scan the store further. This suggests that when the stroke participants had adopted a strategy they may no longer have considered alternative solutions to the problem; they maintained the use of their initial strategy regardless of the efficacy of the solution.

**TBI participants compared to their control group**

With the TBI controls, a pattern similar to the stroke and stroke control groups was noticed in that the number of different strategies used was positively correlated with performance on the BMET. However, overall higher frequency of strategy use was not beneficial for TBI participants. What did seem to help them was the use of task setting strategies, as a higher frequency of use here was generally positively correlated with the
number of tasks completed accurately, suggesting that proper task setting is important for goal-achievement.

If a task is not set properly, proper monitoring will not occur. Perhaps that is why negative correlations where found between monitoring and performance on the BMET for the TBI group. These correlations may be representative of participants in this group who did not set the task correctly in the first place. Alternatively, they may simply not be using the strategies effectively. In order to study this further, future research should keep track of when each task setting and monitoring strategy was used and whether or not their use led directly to the accurate completion of a task.

One monitoring strategy that was positively related to performance for the TBI group was checking their watch within the first 10 minutes of the task. Not all of the participants in this group used this strategy, but its use was positively related to performance. In future studies, watch checks should be counted in relation to when each participant actually reaches the meeting point. In this study, they were counted as watch checks in the first 10 minutes, yet a participant may have gone to the parrot cage 11 minutes into the task and this would still have been marked as correct (participants were given a ±5 minute grace period). Therefore, watch checking may have occurred after the 10 minute mark but before reaching the parrot cage and completing the task accurately. However, this creates a new problem by giving participants who take 15 minutes to get to the parrot cage more time for potential watch checks than those who reach the parrot cage early. This too will have to be taken into account in future studies when counting watch checks.

A negative correlation with performance in the TBI control group was found with frequency of monitoring type requests for help. Like Alderman et al., our study showed an even stronger relationship between these two variables in the TBI group. Alderman et al. (2003) found that one of the best predictors of performance for their control group was the number of requests for help, with more requests being associated with poorer performance. The findings of both studies lead to the hypothesis that participants who more readily ask for help benefit from it the least. Perhaps they were simply not using the strategy efficiently. For example, participants who asked the gift shop cashier for the closing time of the library were less likely to receive a correct answer than those who asked the same question at the information desk. Thus, they needed to request help a second time for the same task.
Negative correlations between performance and both types of self-talk were also seen in the TBI participant and control groups. Although self-talk may seem like a useful strategy, and it often can be, it is known to become internalized with age and with practice when learning a new task. Meichenbaum (1978) has shown that once self-talk becomes internalized, it is best to keep it that way or it can actually hinder performance. Another possible explanation for this relationship between self-talk and performance is that in adults, self-talk often emerges when an interruption or distraction of thoughts and actions occurs, meaning that it is possible that subjects who used self-talk more often were also interrupted or distracted more frequently and that this is what led to their poorer performance.

Significantly more TBI controls asked the examiner questions prior to the start point, leading to a higher frequency of use of this strategy by this group. However this was not related to BMET performance. There was also a trend towards a higher frequency of map checks by the TBI controls. This was also seen with the stroke group as well as in the Knight (2002) study. As with the stroke group, difficulty navigating with a map may have discouraged TBI participants from using this strategy. Also, qualitatively speaking, TBI participants seemed to be attracted to more obvious external stimuli such as the task sheet (which was on top of the map), signs or staff members, and to use strategies related to these stimuli. In fact, some ABI participants occasionally appeared to forget that they had a map, some even asked staff members if there was a map of the hospital posted somewhere that they could use.

Further investigations of results

A few of the correlations were in an unexpected direction thereby warranting further investigation. One of these was the negative correlation ($r_s = -0.43$) for participants with TBI between frequency of task sheet checks and BMET performance. Further analysis indicated that the frequency of task sheet checks was not related to working memory ability for the TBI participants as it was for their controls. TBI participants also marked partial task failures as tasks completed accurately. This suggests that they were unaware of their partial task failures, either because they misinterpreted the task to begin with or monitored poorly while working on it. Both ABI groups looked at signage regardless of their familiarity with the hospital, while their controls decreased dependency on signage and landmarks as their
familiarity with the hospital increased. Not only did the ABI participants look at signage regardless of their familiarity with Baycrest, but the use of this strategy was negatively correlated with tasks completed accurately. This is unlike observations by Knight and colleagues in 2002 where higher frequency of signage use was associated with fewer task failures for their ABI group. It would seem as though using signage would be a useful strategy, especially if navigating with the map was difficult for these participants as discussed earlier. Interestingly since conducting the BMET study, the signage at Baycrest has been improved hospital-wide. This suggests that the hospital signage at the time of the study was not clear, possibly contributing to the negative correlation between use of signage and performance.

Limitations

This study was not without its limitations. Lesion data were not available for most of the participants, making it impossible to compare our findings with the theory that poor task setting strategy use was associated with damage to the left lateral frontal lobe and poor monitoring strategy use with the right lateral frontal. Our sample size was relatively small and made up of ABI participants who were many years post-injury and had been living in the community for several years. These participants were likely to already have adopted many compensatory strategies to assist them in their daily lives. Despite the time spent in rehabilitation and in the community, differences in strategy use and pattern of relationship with performance on the BMET were still seen between ABI survivors and their controls. Future research should also study naturalistic strategy use in a more acute ABI population as this will likely magnify the differences between ABI participants and controls seen in this study. This study was exploratory and the first to develop and use this type of strategy scoring procedure. Therefore, future research needs to be conducted to determine the validity, inter-rater reliability, and intra-rater reliability of this measure and to determine how the strategy score sheet can be revised in order to improve its discriminate ability.

Conclusions

The results from this exploratory study inform us that naturalistic strategy use in stroke survivors is not the same as in TBI survivors. These two populations need to be studied separately if we are to further improve our understanding of naturalistic strategy use in the
ABI population. The relationships between strategy use and performance on the BMET by people with stroke and TBI differed from those of controls. Observing strategic behaviour in the control samples informed us about healthy strategic behaviour and helped to distinguish what was healthy and what was compensatory in the ABI groups. These results indicate that the study of naturalistic strategy use in the ABI population is important. Knowing which strategies ABI survivors with executive dysfunction employ naturally moves us towards a better understanding of how to develop the most effective strategy training interventions for this population. These results are a step towards more effective cognitive rehabilitation interventions for ABI survivors.
CHAPTER 4: Relationship between Naturalistic Strategy Use and Performance on Measures of Everyday Life

Introduction

The purpose of this portion of the study was to assess the ecological validity of the strategy score sheet used in chapter 3 by correlating strategy use with scores on measures of daily life function. Although this chapter is written in manuscript format, it is not intended for further publication, but to add some additional details to the data. A brief overview of the background follows below. For more extensive background information, see the section entitled “Real-world Performance and Ecological Validity” in chapter 2.

In neuropsychology, the term ecological validity is used to describe a test’s ability to predict real-world performance (Chaytor & Schmitter-Edgecombe, 2003). Good ecological validity is seen when a participant’s performance on a test is highly related to his or her real-world abilities. Traditional paper and pencil tests designed to tap into functions commonly associated with the prefrontal lobes have been criticized for their limited ecological validity; patients may perform normally on these tests yet exhibit significant everyday difficulties (Andre et al., 2008; Burgess, et al., 2006; Chaytor & Schmitter-Edgecombe, 2003 & 2006; Manchester et al., 2004; Shallice & Burgess, 1991; Wilson et al., 1998).

There are many possible reasons for the discrepancy between real-world and test performance. In a testing situation, the participant is presented with short-trials, where there is usually only one problem at a time to solve while receiving prompts from the examiner (Shallice & Burgess, 1991). The participant is likely not required to plan or multitask independently (Manchester et al., 2004) and the environment is artificially quiet and structured (Chaytor & Schmitter-Edgecombe, 2003). In contrast, the Baycrest version of the Multiple Errands Test (BMET) used in this study takes place in a naturalistic, real-world setting where the participants must plan, prioritize and multitask without any assistance from the examiner. Performance scores on the BMET have previously been shown to have good ecological validity (Dawson et al., accepted) and the goal of this part of the study was to investigate the ecological validity of the strategy scoring procedure (development described in previous chapter). More specifically, the objective was to determine if and how strategy use on the BMET correlates with performance on four measures measuring aspects of
performance in everyday life: the Assessment of Motor and Process Skills (AMPS), the Zoo Map Test from the Behavioural Assessment of the Dysexecutive Syndrome (BADS), the Mayo-Portland Adaptability Inventory self- and significant-other reports (MPAI and MPAI SO), and the Dysexecutive Questionnaire self- and significant-other reports (DEX and DEX SO). Stroke and TBI participants were compared to their respective control groups due to differences in performance patterns discussed in the previous chapter. Due to the high frequency of decreased awareness of deficits following an ABI (Burgess et al., 1998; Knight et al., 2002; Wilson et al., 1996), both self and significant-other (SO) reports were obtained when possible to provide a more accurate assessment of performance in daily life.

**Methods and Materials**

**Participants**

Participants for this part of the thesis are the 51 people described in chapter 3 and their significant-others (SO). When first recruited, participants were asked if they had a SO such as a spouse, close family member or friend, who would be willing to answer two questionnaires over the telephone for the study. A total of 41 SOs were recruited. They all provided informed, written consent. This second part of the study was conducted in accordance to human ethics standards and was approved by the joint Baycrest/University of Toronto Scientific and Ethics Review Committee.

**Measures**

Two measures of strategy use, the total observed and total frequency scores, and four measures of performance in everyday life, the AMPS, Zoo Map, DEX, and MPAI, were used in this study. Each is described below.

**Strategy use**

In order to examine how overall strategy use was related to performance on measures of everyday life the total strategy scores were used. The total observed strategy use score reflects the number of different strategies each participant employed during BMET completion. The total frequency score is a measure of how many times the observed strategies were used.
**Zoo Map test**

The Zoo Map test is one of the subtests in the Behavioural Assessment of the Dysexecutive Syndrome (BADS) (Wilson et al., 1996). It is a paper and pencil task that requires the participants to visit specific areas on the map of a zoo. Included are a set of rules that must be followed such as respecting the designated start and end areas and no backtracking. The zoo map contains 12 areas but only 6 are to be visited. In order to visit all 6 areas without breaking any rules the participant must plan ahead. It has been found to have good inter-rater reliability (between .90 and 1.00 depending on the item being scored). The Zoo Map test was chosen for use in this study because it was designed to predict everyday problems associated with planning and problem solving (Norris & Tate, 2000), its task demands are similar to those of the BMET (both require the participants to plan, navigate between areas on a map and follow a set of rules), and it has been used in previous MET studies (Alderman et al., 2003; Knight et al., 2002). Scaled scores were used in the analyses.

**AMPS**

The AMPS test is a standardized performance evaluation of goal-directed actions that are important for activities of daily life (Fisher, 2001). It requires participants to complete 2 tasks (e.g., make an omelet, toast and beverage; clean a bathroom; and vacuum two rooms on two different levels) representative of activities of daily living which they find meaningful. The tasks to be completed are chosen based on the results of an interview about the participant’s perceived level of functional ability. A process score, which represents the person’s abilities to carry out and modify the task efficiently and appropriately, and a motor score, which represents the person’s overall motor skills when handling objects or moving about, are derived from the assessment. These scores are used to determine if the person has the motor and process skills needed for the safe, efficient, and independent performance of activities of daily life. This test has been previously validated on tens of thousands of subjects and was designed to be suitable for application regardless of diagnosis. Although the assessment process is structured, AMPS scores are representative of a person’s ability to be independent in their everyday life.
DEX

The DEX (Wilson et al., 1996) is a highly reliable (Cronbach’s alpha of 0.85) (Bodenburg & Dopslaff, 2008) questionnaire containing 20 items related to executive difficulties encountered in the everyday. These items load onto five factors, each related to a different aspect of the dysexecutive syndrome: 1) Inhibition 2) Intentionality 3) Executive Memory 4) Positive Affect and 5) Negative Affect (Burgess et al., 1998). The DEX has a self and a significant-other version, both of which require the rater to identify the frequency of occurrence of each item on a 5 point Likert scale ranging from never (0) to very often (4). Previous work (Burgess et al., 1998) has reported that neurological patients rate themselves significantly lower (i.e., less severe dysexecutive problems) on the DEX than their significant-others, suggesting that patients are less aware of their deficits and supporting the use of the SO report in this study. The DEX is also part of the BADS though its score is not used in the battery’s profile score calculation but rather provides supplementary information (Wilson et al., 1998). It has also been used in prior MET studies (Alderman et al., 2003; Knight et al., 2002).

MPAI

The MPAI is a 29-item questionnaire with a self and a significant-other version designed for use with postacute ABI survivors (Malec & Lezak, 2003). It has good internal consistency and concurrent and predictive validity (Malec & Lezak, 2003). It is made up of three subscales designed to reflect the World Health Organization’s International Classification of Functioning and its distinction between impairment, activity and participation. With these three subscales the MPAI provides three scores: 1) the Abilities score obtained is a reflection of the person’s motor, sensory and cognitive impairments, 2) the Adjustment score pertains to their mood and interpersonal interactions and 3) the Participation score is intended to represent the International Classification of Functioning definition of participation and includes items regarding social contacts, initiation and money management. The 29 test items are scored on a scale of 0 to 4 reflecting the level of interference in daily life activities, participation or independence with 0 representing no interference and 4 representing interference more than 75% of the time. Three of the test items, namely initiation, social contact and leisure/recreational activities, contribute to both the adjustment and participation
scores. As in the Dawson et al. (accepted) study, only these two scores were used here as they were deemed most relevant in the exploration of our measure’s relationship to performance in everyday life. The comparison of self and SO reports previously identified a variety of potential biases that can affect both these scores (Malec & Lezak, 2003); the person with ABI might have a lack of self-awareness and aspirational bias while their SO may be concerned with the impact and burden the score may have. Self and SO reports varied in their degree of agreement depending on the case suggesting it is beneficial to use both versions for a more accurate assessment of the person with ABI.

Procedure

In order to investigate the relationship between strategy use on the BMET and everyday behaviour the real-world measures described above were administered to all 51 participants. The SO versions of the DEX and MPAI were administered via the telephone to the 41 SOs recruited. All real-world measures were administered by a trained research assistant and the AMPS was administered in a real-world setting (i.e., the participant’s home) by an AMPS-certified occupational therapist. Strategy use was measured using the BMET videotapes and scripts as described in chapter 3. The strategy score sheet is provided in Appendix E.

Planned Analyses

Scores on the measures of performance in everyday life were correlated with strategy use using Spearman correlations. This non-parametric analysis was chosen because the data did not meet the assumption of normality. All of the measures of performance in everyday life and two strategy scores were included in the analyses due to the exploratory nature of this study and the results from these multiple comparisons are considered in this light. Only the 41 participants with an SO were included in the correlations involving the MPAI and DEX self-report scores to ensure these correlations would be comparable to those found with the MPAI and DEX SO-reports. Correlations that were moderate ($r = .30$) or stronger were considered favourable as a correlation of $r = .30$ accounts for about 10% of the variance (Norman & Streiner, 2008).

A high score on the motor subscale of the AMPS is related to less physical effort needed to complete the task, a high AMPS process score signifies more efficient task performance, and a higher overall score on the Zoo map test is associated with better planning and problem
solving abilities. The opposite occurs when scoring the MPAI and the DEX; higher scores are representative of more impairment and executive problems, respectively. For clarity, the DEX and MPAIs were rescored so that positive correlations here would also indicate that better performance was associated with increased strategy use.

Results

Spearman correlations were conducted between scores on measures of everyday life and two of the strategy scores (total strategies observed and total frequency). Correlations of .30 or stronger can be seen in Table 4.1 (all of the correlations can be seen in Appendix G). Nineteen out of 30 of these (63%) indicate a weak relationship between measures of everyday life and strategy use (r > .30 and <.50). Strategy use is most consistently correlated with scores on the AMPS where 10 out of the possible 16 correlations (63%) are equal or greater than .30 and the majority of these (6/10, 60%) are moderate to strong (r > .50).

<table>
<thead>
<tr>
<th>Measures of everyday life</th>
<th>Stroke n = 14, n(SO) = 14</th>
<th>Stroke control n = 13, n(SO) = 10</th>
<th>TBI n = 12, n(SO) = 9</th>
<th>TBI control n = 12, n(SO) = 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMPS mot</td>
<td>-.36 Total observed</td>
<td>.51 Total frequency</td>
<td>.75* Total observed</td>
<td>.54 Total frequency</td>
</tr>
<tr>
<td>AMPS pro</td>
<td>-.68* Total observed</td>
<td>-.53 Total frequency</td>
<td>.43 Total observed</td>
<td>.30 Total frequency</td>
</tr>
<tr>
<td>MPAI adjustment‡</td>
<td>-.34 Total observed</td>
<td>-.52 Total frequency</td>
<td>-.33 Total observed</td>
<td>.35 Total frequency</td>
</tr>
<tr>
<td>MPAI participation‡</td>
<td>-.63 Total observed</td>
<td>-.63 Total frequency</td>
<td>.45 Total observed</td>
<td>-.47 Total frequency</td>
</tr>
<tr>
<td>MPAI SO adjustment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MPAI SO Participation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEX‡</td>
<td>-.30 Total observed</td>
<td>.39 Total frequency</td>
<td>.53 Total observed</td>
<td>.44 Total frequency</td>
</tr>
<tr>
<td>Zoo Map Test</td>
<td>.36 Total observed</td>
<td>.35 Total frequency</td>
<td>.33 Total observed</td>
<td></td>
</tr>
</tbody>
</table>

† Two-tailed Spearman correlations were used to determine the relationships. Correlations <.30 were not included for clarity.
‡ Only the 41 participants with an SO were included in these correlations.
* p < .05

Comparisons between stroke participants and their controls

In the stroke group more strategy use was associated with worse performance in everyday life as measured by the AMPS (rs = -.36 to -.68), the MPAI self and SO reports (rs = -.34 to -.37), and the DEX (rs = -.30) while greater strategy use was associated with better performance on the Zoo Map test (rs = .35 and .36). The control group showed a different pattern with more strategy use being associated with better performance in everyday life as measured by the AMPS (rs = .30 to .75) and the DEX SO (rs = .39 to .53), worse performance
as measured by the MPAI ($r_s = -.31$ to $-.53$), and no relationship between strategy use and performance on the Zoo map test.

**Comparisons between TBI participants and their controls**

As was seen when comparing stroke participants and their controls, more strategy use was related to worse performance on the AMPS for the TBI group ($r_s = -.46$) yet better AMPS performance for their controls ($r_s = .54$ to $.56$). For the TBI group, more strategy use was related to better performance in everyday life as measured by the MPAI SO adjustment scale ($r_s = .31$), the DEX SO score ($r_s = .44$), and the Zoo Map test ($r_s = .33$). More strategy use for their controls was also correlated with better performance in everyday life as measured by the DEX ($r_s = .43$) yet with worse performance on the MPAI SO participation subscale ($r_s = -.37$). No relationship between performance on the Zoo map test and strategy use was found for the TBI controls.

**Discussion**

The purpose of the second part of this study was to assess the ecological validity of the BMET strategy scoring procedure used in chapter 3 by correlating scores on measures of everyday life with strategy use. Results indicated that the relationship between strategy use and real-world performance differs depending on the population and the real-world measure in question. Differences in patterns of relationships between the two ABI groups were also found, indicating the importance of etiology and lesion data for future strategy use research. Overall, the results indicate that the strategy scoring procedure has some ecological validity and the potential to be clinically useful in the field of cognitive rehabilitation.

The AMPS motor and process scores were most consistently correlated with strategy use across all of the 4 groups. The strongest ($r_s = -.68$ and $.75$, $p < .05$) correlations were also found between the AMPS scores and strategy use. These results indicate that strategy use on the BMET was most related to real-world functions as measured by the AMPS. Unlike the MPAI and DEX which are in questionnaire format, and the Zoo map test which is a paper and pencil task, the AMPS required the participants to actually perform activities of daily living. This naturalistic format, along with the AMPS’ strong reliability and validity, likely resulted in the stronger correlations seen between AMPS scores and strategy use on the BMET.
Interestingly, all of the correlations between the AMPS motor and process scores and strategy use for both ABI groups were negative while for both control groups they were positive. Therefore, ABI participants with worse AMPS scores used more strategies and/or used them more frequently while the opposite was true for controls. Poor performance on the AMPS indicates that the person does not have the motor and process skills needed to complete everyday tasks in a safe, independent and efficient manner (Fisher, 2001). Although the AMPS provides both a process and a motor score, it is important to note that the underlying physical and cognitive capacities associated with performance on either scale interact strongly with one another. For example, a person with motor skill difficulties must come up with alternative strategies to compensate for their motor problems, thereby placing added strain on process skills such as the ability to use “cognitive compensation” (Fisher, 2001). The negative relationships in the ABI group likely reflect the need to use many compensatory strategies to make up for physical and cognitive deficits impacting performance in daily life situations. For the control groups, the positive correlations likely reflect the ease with which participants with good motor and process skills can employ a variety of strategies.

Like with the AMPS, worse scores on the MPAI self and SO reports were associated with a greater variety and/or frequency of strategy use for the stroke participants and their controls as well as for the TBI controls. These results suggest that participants with poor interpersonal interactions and less participation in daily life activities are either overusing strategies because they are not being effective for them or that they are compensating for their deficits with a wider range or greater frequency of strategy use. These results are in line with the correlations found between DEX scores and strategy use in the stroke group as worse DEX scores, indicating a higher frequency of dysexecutive problems in everyday life, were related to more strategies being observed.

For the TBI participants, MPAI adjustment and DEX SO scores were positively correlated with strategy use. Positive correlations between DEX scores and strategy use were also seen in the two control groups. This relationship indicates that those with more interpersonal interaction difficulties and greater dysexecutive problems used fewer strategies or used them less frequently. Perhaps their difficulties in the real-world prevented them from
using many strategies. For example, participants with poorer interpersonal interaction skills may have avoided requesting help from staff.

Both the stroke and the TBI participants’ performance on the Zoo Map test was positively correlated with their strategy use on the BMET indicating that better performance on the Zoo Map test is associated with higher strategy use scores. This correlation was in the expected direction since the Zoo Map test is somewhat similar to the BMET. Although simpler and done on paper instead of in the real-world, the Zoo Map incorporates the aspects of planning, sub-goal achievement and a list of rules to be obeyed, all of which are important for good Zoo Map performance, are features of the BMET, and play a role in strategy use. Although they did not measure strategy use, Knight et al. (2002) also found a relationship between scores on the Zoo Map and BMET performance where the Zoo Map was moderately negatively correlated with the number of task failures on their hospital version of the MET. They suggested that this was due to similar planning and memory requirements associated with both tests. Similarly, Alderman et al. (2003) found a correlation between the number of task failures on their shopping mall version of the MET and performance on the Zoo Map test.

The two ABI groups showed different patterns of relationships between performance on measures of everyday life and strategy use. Some of the everyday measures were correlated for one ABI group but not the other, sometimes the correlations were with the total observed score in one ABI group but the total frequency score in the other, and in some instances the direction of the correlation differed between the two groups on the same measure. As was mentioned in chapter 3, these differences might be associated with the nature of the etiology (i.e., TBIs are often diffuse injuries (Levine et al., 2008)) or lesion location. Future studies on strategy use should continue to look at stroke and TBI participants separately or incorporate the use of neuroimaging technology to accurately map out lesion location and divide the groups based on this variable.

Future studies should also investigate the further fractionation of the task setting and monitoring definitions (Stuss & Alexander, 2007). Perhaps this could be used to further subdivide the strategies and obtain strategy use sub-scores. For this study, the score sheet divided the strategies into task setting and task monitoring only yet sub-scores of these processes might correlate more strongly and consistently with measures of everyday life for
all four groups, thereby improving the ecological validity of the scoring procedure. For example, during the scoring process, strategies used to monitor for errors, such as when participants ask a staff member if they are going the right way to reach the library, could be scored together to form a sub-score of “error monitoring strategies”. Using the total scores such as the total number of task setting or monitoring strategies or the total number of strategies observed and total frequency of strategy use (as was done here) may be washing out relationships that would potentially surface if correlating strategy use sub-scores with performance on measures of everyday life. Lastly, the participants used in this study were many years post-injury and had been living in the community for many years. It is expected that this would have an effect on strategy use as they would have learned to use strategies in their everyday lives to compensate for their deficits. It would be interesting to see how strategy use in an acute sample differs.

This study did have its limitations. As mentioned above, the ABI sample was many years post-injury and made up of community dwelling survivors who had likely learned to implement many compensatory strategies into their daily lives. Lesion data and the further subdivision of the strategy scores to obtain task setting and monitoring strategy subscores was not possible in this study but would likely improve the strength of the correlations, thereby improving the ecological validity of the strategy score sheet. Lastly, not all of the participants had an SO willing to participate in the study, shrinking our small sample size even further for the MPAI and DEX correlations.

Conclusions

The BMET strategy scoring procedure developed and applied in chapter 3 was related to performance on measures of everyday life. Strength of relationships ranged from weak to strong ($r_s = .30$ to $.75$) depending on the measure of everyday life and the group in question. Overall, the direction of the correlations indicated that ABI participants with poorer participation and performance in the real-world used more strategies than their more able counterparts. Different patterns of relationships emerged across the 4 groups and more importantly between the ABI groups, once again providing support to the idea that future strategy use studies should incorporate lesion location data. Despite these difference between groups, the AMPS was consistently and strongly correlated with strategy use on the
BMET, indicating that the scoring procedure does have good ecological validity, especially when it comes to predicting real-world ability as measured by the AMPS. It is hypothesized that further fractionation of the strategy scores using a more developed definition of task setting and monitoring may improve the ecological validity of the strategy scoring procedure. This exploratory work was a good starting point for the investigation of naturalistic strategy use in ABI survivors with executive dysfunction. Future studies needs to look into furthering the development of the strategy score sheet and the BMET, and use a carefully selected sample (i.e., lesion data and an SO for each participant, comparisons between acute and chronic participants). This would likely improve the ecological validity of the strategy score sheet and its potential for clinical utility in cognitive rehabilitation.
CHAPTER 5: Discussion

The main purpose of this study was to further our understanding of how acquired brain injury survivors with executive dysfunction naturally employ strategies as they attempt to complete tasks and how these strategies either move them towards their goal or impede it. As part of the theory-based investigation, some of the major theories of executive functioning were explored and described in the introduction. Aspects of the theory on the fractionation of the prefrontal lobes (Stuss et al., 1995) served as the theoretical basis for the development of our strategy scoring procedure. The results indicated the importance of differentiating processes when studying real-world performance. All of this is reviewed below along with study limitations and suggestions for how future strategy research can be informed by these data.

Theories Related to Executive Functions

Four theories of executive functioning were reviewed in Chapter 2: Duncan’s adaptive coding model, Baddeley’s central executive theory, the supervisory system theory and Stuss and colleagues’ fractionation of the anterior attentional system theory. Duncan and Baddeley’s theories view the frontal lobes as having a general supervisory function. In Duncan’s adaptive coding model, the prefrontal lobes are seen as a single unit with some important regional specifications within it. Duncan suggested that the division of the prefrontal lobes into more defined regions, with each responsible for a specific cognitive process, might not be possible (Duncan & Miller, 2002). Instead, his model suggests that the prefrontal lobes function more generally, like a computational resource that can adapt to solve various cognitive problems. Similarly, Baddeley’s working memory theory (Baddeley, 1986) has linked some functions of the central executive to the prefrontal lobes (Baddeley, 1996; Baddeley, 2002) but defined prefrontal areas have yet to be associated with specific functions of the central executive. The central executive remains a sort of “ragbag” (Baddeley, 1996) responsible for complex functions such as strategy selection, planning, and retrieval checking.

The results from our study do not appear to support these theories. When looking at the total strategy use scores (total strategies observed and total frequency of strategy use) and how these correlated with performance on the BMET, we saw few results. Use of individual
strategies, however, was correlated with performance suggesting that strategy use is not one global executive process governed by the prefrontal lobes in general.

Norman and Shallice’s Supervisory System Theory (1986) posited the prefrontal lobes housing a single overriding system, the supervisory system. However, lesion and neuroimaging studies have shown evidence of fractionation of the supervisory system; that is, various subcomponents are related to specific parts of the prefrontal lobes. Shallice (2002) discusses evidence that the modulation of schemas appears to be localized in the left dorsolateral prefrontal cortex with monitoring and checking in the right. The right ventrolateral prefrontal cortex seems to be involved in the specification of a needed memory trace and Brodmann area 10 has been associated with the formation of intentions for delayed use and their realization. Much of this evidence supporting the fractionation of the supervisory system has been provided by the work of Stuss and colleagues. Building from Norman and Shallice’s theory, they developed a research program that allowed them to further fractionate and define frontal processes (Stuss & Alexander, 2007; Stuss et al., 1995). Two of the frontal processes defined were most relevant in our study of naturalistic strategy use: task setting, which is a function of the left lateral prefrontal lobe, and monitoring, which is a function of the right lateral frontal lobe. The clear definitions of these two processes (Stuss & Alexander, 2007) allowed us to categorize the strategies into task setting type and monitoring type strategies.

Our results provide support to the theories of fractionation of the prefrontal lobes (Stuss et al., 1995; Shallice, 2002; Stuss & Alexander, 2007). Using Stuss’ theory as the basis for our strategy categorization, we found a pattern of overall positive relationships between the use of task setting strategies and BMET performance, and overall negative relationships between the use of monitoring strategies and performance in the TBI group. These results can be related to those of Alderman et al. (2003) regarding “task failer” and “rule breaker” type participants. “Task failers” were participants with a higher number of task failures and inefficiencies (defined as when a more effective strategy could have been used) while “rule breakers” broke more rules and made more interpretation failures (defined as misunderstanding the task requirements). “Rule breakers” performed significantly worse than “task failures” on their version of the MET. If looking at these data within the context of the theory on the fractionation of the prefrontal lobes, “task failers” had difficulty setting
the task while “rule breakers” had more problems monitoring their behaviour. Therefore, in the current study, as well as the Alderman et al. (2003) study, difficulty monitoring was associated with poorer performance than difficulty task setting. These results suggest that multiple processes are operating concurrently and that the prefrontal lobes do not house a single, overriding, supervisory system. Also, the fact that many strategies were only weakly correlated with performance in our study suggests that there may be more results to be found with a more precise strategy scoring technique.

The question thus arises – how could one develop a more detailed strategy scoring method? One option is for the theory it is based upon to be further detailed. As was suggested in his 2007 paper, the constructs of task setting and monitoring are still too broad (Stuss & Alexander, 2007). These results both support and inform Stuss’ theory on the fractionation of the prefrontal lobes, thereby helping to move forward our understanding of task setting and monitoring. Once more detailed, the constructs of task setting and monitoring could be used to divide the strategies into sub-groups of task setting and monitoring strategies. For example, task setting strategies could play a role in setting the stimulus-response relationship or in the adjustment of contention scheduling while monitoring strategies might be divided into monitoring the timing of the activity and monitoring for performance errors.

**Context in Strategy Scoring**

One of the values of using naturalistic assessment to explore strategy use was that this revealed the importance of context in strategy use. Accounting for this during strategy scoring is another way to develop a more detailed strategy scoring method. To the best of my knowledge, no-one has looked at strategies in relation to the MET or other naturalistic assessments in this way. Examining the strategy “requesting help” illustrates this possibility. Requesting help is a strategy that has been reported in previous papers on the MET (Alderman et al, 2003; Dawson et al., accepted; Knight et al., 2002) and all have indicated that participants in the ABI group use this strategy more than their controls. However, I hypothesized that requesting help from a staff member in the form of asking how to get to the resident library is a task setting process whereas asking a second staff member the same question (same behaviour) may reflect a different process. Depending on the context, it may
be a monitoring process; one participant did this to confirm that he was still going the right direction when on his way to the resident library. It can also be a task setting process; further task setting was needed because the first staff member did not know the answer, gave an answer he or she was not sure about or gave an answer that was not clear to the participant. For example, when asked by a participant where the resident library was, a staff member in this study hesitated before replying and telling the participant where he “thought” the library could be found. The staff member did not seem confident in his answer and the participant proceeded to ask the same question to the next staff member he encountered. Grouping all of the requests for help into one total score may have obscured findings in the previous studies (Alderman et al, 2003; Dawson et al., accepted; Knight et al., 2002) which would have emerged had the requests for help been divided based on context. Context was also taken into account when scoring self-talks. Participants used self-talk both to task set (e.g., “I’m gonna mail this”) and to monitor their performance (e.g., “Oh geez” when noticing an erroneous behaviour).

These examples illustrate the complexity of investigating naturalistic strategy use behaviours. This exploratory study allowed us to identify the importance of context when studying naturalistic strategy use in survivors of ABI. Theoretically, many of the other strategies could be sub-divided and scored differently based on context, such as described above for the requests for help and self-talks. Checking the task list, map and watch are some strategies that are presumably done for different reasons at different points in the overall assessment. In this study, use of the map and task list were divided based on time into “checks” and “reads” (looking at the map or task sheet for five seconds or more). However these could have been scored individually and based on context instead. If the person glances down quickly while on their way somewhere it is a monitoring type map check or task sheet check. On the other hand, a quick glance followed by a look up and down the hall, at the very start of the task is a task setting map check or task sheet check, regardless of whether it lasted more than 5 seconds or not. As for watch checks, the use of this strategy is directly related to the task of meeting the examiner at the parrot cage 10 minutes after the start of the test. Therefore, checking the watch at the start of the task to set the meeting time was counted as a task setting strategy and further watch checks that occurred prior to the 10 minute mark were considered monitoring behaviours. However, participants were given a
grace period of plus or minus 5 minutes. Therefore, watch checks should have been scored in relation to when the participants actually met the examiner at the parrot cage. In one video, a participant was quite late meeting at the parrot cage due to a long line for the cafeteria cash register. Just before his turn at the cash register came, the cashier spent excessive time talking with a customer and then realized her cash register was out of change and she could not serve any customers until another employee brought her more change. When looked at in context, this participant had set the parrot cage task correctly and checked his watch often while in line at the cafeteria, indicating that he was using an appropriate monitoring strategy. His flustered appearance suggested that he was aware he would be tardy. This example once again illustrates the importance of context in analyzing strategy use.

The division of strategies into task setting and monitoring allowed us to identify the monitoring difficulties of TBI participants. This study took into account the context of the situation when scoring requests for help and self-talks, allowing these to be divided into task setting and monitoring type strategies. This study also allowed us to identify other strategies that could be used to set the task or monitor behaviour, depending on the situation (e.g., map and task sheet checks, watch checks). Once context and sub-components of the task setting and monitoring process are further accounted for, we hypothesize that scoring naturalistic strategy use will produce stronger and clearer results.

**Etiology and Naturalistic Strategy Use**

Another critical finding of this study was that the patterns of relationship between strategy use and BMET performance (chapter 3), and measures of everyday life (chapter 4) were different between the stroke and the TBI groups. These data highlight the fact that, although stroke and TBI can both affect prefrontal lobe function (Levine et al., 2008), this does not mean they affect cognitive and real-world performance in the same way. Levine and colleagues (2008) provided a detailed summary of the different types of strokes, areas of the prefrontal lobes they affect, and resulting behavioural manifestations. Brain lesions due to stroke are generally more focal in nature and are thereby associated with more specific behavioural manifestations. In contrast, closed head injuries related to acceleration-deceleration forces (the etiology of all people with TBI in this study) lead to diffuse damage
as the brain is subjected to strong inertial forces that cause it to shift and twist within the confines of the skull. This can lead to focal parenchymal injury of ventral frontal lobes (due to the bony ridges of the inner skull), as well as to diffuse axonal injury, both of which can adversely affect prefrontal lobe functioning even in the absence of direct impact to this brain region. In the case of diffuse axonal injury, the vast network of interconnections between the prefrontal lobes and other brain regions is disrupted, thereby affecting the proper functioning of the prefrontal lobes.

Past research has indicated that lesion location is more important than etiology (Elsass & Hartelius, 1985; Stuss et al., 2005). The incorporation of neuroimaging in future studies would allow for the study of naturalistic strategy use in relation to lesion location. We hypothesize that more correlations between strategy use and performance on the BMET would come through using this method. It is likely that patterns would emerge indicating that participants with left lateral damage were not using task setting strategies efficiently, participants with right lateral damage were having difficulty using monitoring strategies, while participants with diffuse injuries involving both the right and left prefrontal lobes would have difficulty with task setting and monitoring strategies.

Therefore, although stroke and TBI patients are often studied together in rehabilitation research (Kaschel et al., 2002; Ownsworth et al., 2000; Ownsworth & McFarland, 1999) and in previous MET research (Alderman et al., 2003; Knight et al., 2002; Rand et al., 2008), our findings, and those of Dawson et al. (accepted), indicate that these two populations are different in the way disablement is manifested. This suggests that further research on naturalistic strategy use in the stroke and TBI populations should study these groups separately or whenever possible should be based on lesion location in addition to etiology.

**Real-world Performance and Ecological Validity**

In the introduction, the concepts of real-world performance and ecological validity were discussed. Good ecological validity is when a patient’s performance on a test, in this case strategy use on the BMET, is highly related to performance on real-world measures (Chaytor & Schmitter-Edgecombe, 2003), which in this study were the AMPS, MPAI, DEX and Zoo map test. The AMPS scores were most consistently correlated with strategy use on the BMET in the ABI and the control groups. The strongest correlations were also between this
measure of everyday performance and strategy use ($r_s = -.68$ and $.75$). These results suggest that strategy use on the BMET is a good predictor of real-world performance as it is measured by the AMPS. The naturalistic format of the AMPS likely played a role in these findings. Like the MET, the AMPS requires participants to actually perform everyday tasks in a real-world environment (Fisher, 2001). The other measures of everyday life used in this study were self and significant other reports or paper-and-pencil tasks making them less real-world in nature which perhaps explains why they did not relate as strongly and consistently with strategy use on the MET.

Other factors potentially limiting the ecological validity of the strategy score sheet in this study are the lack of SOs willing to participate and the post-acute nature of our ABI sample. The ABI participants used in this study may have learned to use many compensatory strategies in their daily lives and it would be interesting to observe how strategy use on the MET and other measures of performance in everyday life differs in a more acute sample. Also, improving the strategy scoring procedure as described in the previous section should lead to more precise strategy scores, thereby strengthening these relationships and improving the ecological validity of the strategy scoring method.

**Improving the BMET for Future Strategy Use Research**

Although revising the BMET was not an objective of my research, this study has led me to consider whether revisions to the task and rule list would allow for a more naturalistic assessment of strategy use that would better highlight pathological behaviour. One of the rules and two of the tasks in particular seem to pose a problem. The rule of not going into the same area twice was not clear and was misunderstood by participants in the ABI and control groups. The rule was intended to tell participants that they could not use the same service, such as the information desk, or enter the same area, such as the gift shop, more than once. However, some participants understood this as not using the same hallway more than once. These participants had incorporated an additional restriction into the task that complicated their planning and navigation during the task. Rewording of this rule to make it clearer would ensure that all of the participants were completing the test with the same restrictions.
The task of meeting the examiner at the parrot cage 10 minutes after the start time seemed to cause some confusion for participants in all the four groups. Some of them misunderstood and thought they had to finish as many tasks as possible in 10 minutes and that meeting the examiner was the end point. Others took the time they needed to complete the task list and then met the examiner at the parrot cage when they felt they were finished, regardless of how much time had gone by. To prevent these misunderstandings, further studies will need to make it clear that the parrot cage is not the end point and that the 10 minutes is not a time limit. Perhaps framing the task differently, so that it is more representative of a real-world situation, where a person may have to meet with a friend at a certain time during the day while they are running errands would provide an efficacious modification to the present task parameters.

The task of picking something up for the examiner from the info desk also caused problems for many participants. Looking back, having the participant pick up an envelope marked “For the URGENT attention of ‘examiner’s name’” was somewhat artificial in that an envelope that truly was urgent would not be left at an information desk, it would be immediately delivered. Having the participants pick up an envelope addressed with their initials to be opened by them and containing a message addressed to them might be more representative of an everyday situation. Also, the message in the envelope could read something like “If you have not already purchased a can of coke, do so immediately”. This would be representative of an immediate interruption of everyday activity and would mean that the participants now had to reset their task and re-adjust their present plan. Interruptions are a part of daily life and a task such as this would allow us to more effectively analyze which strategies the participants’ would use in such a situation. We would speculate that control participants should have no problems adjusting to the interruption while we would expect ABI participants to have more difficulty, especially those with task setting problems.

Making these modifications to the BMET could make the assessment more representative of everyday life and allow for better discrimination between patients and controls. Removal of the opportunities for misunderstanding should remove many of the inherent problems experienced by the control participants and participants from the patient groups. Thus, if performance on the tasks discriminates control and patient groups more clearly, more evident differences in naturalistic strategy use will likely emerge as well.
In addition to task and rule changes there are several administrative changes that would facilitate future research on this tool. A quick and simple change would be to wire the participant with a small, non-intrusive microphone. This would allow requests for help and self-talk to be better monitored. Often times, the participants were in a noisy area of the hospital or spoke too softly for their voice to be captured by the video camera’s built in microphone, making it difficult to differentiate between monitoring and task setting types of requests for help and self-talk since the context of the situation could not be heard.

Counting the number of times a participant used signage was difficult as it was not always clear where the participant was looking. At times, it appeared the participant was looking up at a sign but the sign was not visible on the videotape and therefore this could not be confirmed. In order to be as inconspicuous as possible, the examiner and camera person often followed the participants from behind making it difficult for the map and task sheet checks to be counted as well. Eye tracking technology, which uses a computer sensor to detect a person’s gaze (Exton & Leonard, 2009), could be incorporated into the BMET administration process to solve this problem. According to a recent review (Exton & Leonard, 2009), eye tracking technology has seen great advancements in the past few years and today’s eye tracking tools are non-invasive.

In addition to clearer audio and eye tracking data, the use of an event recorder, such as Behavior Tracker (Behaviortracker.com), would allow for the frequency, duration and time of occurrence of each strategy to be tracked from the video tapes. Used together, these tools would allow for a more precise and accurate strategy scoring method.

It would be remiss not to mention virtual reality in relation to the MET. Using a virtual environment would come with its advantages. For example, it would allow for standardization of the MET; the same version could be used in hospitals all over the world and results would be comparable to each other. The use of virtual reality would also allow patients who can not perform the traditional MET due to mobility or safety concerns to be assessed safely. Previous research on assessing cognitive functioning using virtual reality have shown promising results (see Rizzo et al., 2004 for review) suggesting that the use of virtual reality may be a useful tool to assess behaviours and cognition in patient populations. Recently, a virtual MET was developed and tested on post-stroke patients and controls (Rand et al., 2008). Preliminary results indicated that the virtual MET was able to discriminate
between the stroke and control groups and that performance on the virtual MET was moderately to strongly correlated with performance on the regular shopping mall MET. However, these results were for measures of performance, not for strategies. For their one measure of strategy use, a weaker correlation between the regular MET and virtual MET was found ($r = .44$). This suggests that measures of strategy use may show greater variance between a real and virtual environment than measures of performance. Although strategy analysis in a virtual environment does have its advantages, research in this area should proceed with caution to ensure that the real-world, naturalistic qualities of the assessment are not compromised for administrative ease.

**The Importance of Strategy Research for Cognitive Rehabilitation**

The findings obtained from analyzing naturalistic strategy use in this study provided additional information about the participants’ executive and real-world abilities that was not obtained through the initial performance errors analysis (Dawson et al., accepted). This highlights the importance of analyzing naturalistic strategy use in ABI patients through functional assessments for a more informed rehabilitation process. Although the concept of using strategy training for post-ABI interventions is not new (the 2005 review by Cicerone and colleagues listed strategy training as a clinical recommendation for the remediation of deficits in attention, executive dysfunction and problem solving), a better understanding of naturalistic strategy use would lead to the development of more targeted strategy training interventions in patient populations. As was shown in this study, the BMET provides one avenue to further this rehabilitation research.

Our data illustrated that strategies must be employed appropriately to be efficient. An example of inappropriate strategy use was seen in the TBI group, where a higher frequency of task sheet checking was related to poorer performance on the BMET. This suggested that watching the participant check the task list was not reflective of what the participant was actually doing. For example, was the participant gathering information from the task sheet? Was the participant paying attention to the information available on the task sheet or not? Therefore, strategy training that simply teaches a patient to check a task list may be superficial and may not actually be teaching them to set a task appropriately. Increasing the awareness of this issue in the field of cognitive rehabilitation will allow clinicians to
incorporate this knowledge into their practice to ensure their patients are using strategies effectively.

By understanding naturalistic strategy use, we can understand how to better instruct strategies in rehabilitation so that they are useful for patients. This study is one step toward informing rehabilitation assessment and strategy training for survivors of ABI with executive dysfunction. To take things further, similar strategy analyses could be developed for other real-world tasks such as the Instrumental Activities of Daily Living Profile (Bottari, Dassa, Rainville, & Dutil, 2008). Being able to observe and compare strategy use in ABI and healthy control participants on other real-world assessments would be an important step in understanding naturalistic strategy use in the ABI population and would further inform the field of cognitive rehabilitation.

**Limitations**

One of the limitations of this study was the sample used. It was relatively small, with an even smaller SO sample because not all of the participants had an SO willing to participate. The ABI participants were many years post-injury and living in the community, meaning that they would likely have learned to use compensatory strategies to help them in their everyday life. The lack of neuroimaging data on the ABI sample meant that we could not examine strategy use in relation to lesion nature (focal vs. diffuse) or location. A second limitation relates to the psychometrics of the score sheet. While the original score sheet had good inter-rater reliability between people scoring from the videotapes, the reliability of the revised score sheet has not been established. Further intra-rater reliability has yet to be established. Limitations of the BMET and its administration procedure also impacted this study. Revising the BMET was not an objective of this research project but revisions to some of the rules and tasks would allow for a more naturalistic assessment of strategy use. During the administration of the BMET, a videocamera was used to capture the strategies for future scoring. Although this was a good start, it became evident through this study that the camera was not able to capture all of the audio and visuo-details needed for accurate strategy scoring.

**Future Directions**

Future research should address the limitations described in the previous section to help further our understanding of naturalistic strategy use in ABI survivors with executive
dysfunction. Future work should consider the further development of the strategy score sheet to incorporate context and the division of the strategies into task setting and monitoring, as well as the use of neuroimaging techniques. Modifications to the rules and tasks of the BMET would allow for a more naturalistic assessment of strategy use and the addition of technological aids would allow for more precise strategy scoring.

In summary, results obtained in this study have major implications for future research. The next steps are to incorporate these aspects into studies using a revised BMET or other real-world assessments, such as the Instrumental Activities of Daily Living Profile (Bottari et al., 2008). This type of work also has important clinical implications as information obtained from these studies can be incorporated into assessments to improve their clinical utility and lead to the development of more targeted rehabilitation programs.
CHAPTER 6: Conclusion

This research study explored naturalistic strategy use in survivors of ABI with executive dysfunction. Results indicated that the patterns of relationships between strategy use and performance on the BMET differed between ABI participants and their controls. For a few strategies, the proportion of participants in the ABI groups and the control groups who employed each strategy as well as the frequency of use of each strategy differed as well. Relationships between strategy use and performance on the BMET were also different between the two ABI groups. Higher frequency of strategy use was associated with better performance for stroke participants. For the TBI participants the use of task setting strategies was also positively related to performance while the opposite was true for the use of monitoring type strategies. Principles from Stuss’ theory on the fractionation of the prefrontal lobes informed the development of the strategy score sheet. Using the concepts of this theory enabled the understanding of peoples’ naturalistic strategy use and in turn the study’s results provided support to the value of this approach. Our results also support the suggestion that further fractionation of the task setting and monitoring processes might be even more beneficial. As was seen in Chapter 4, the strategy scoring procedure was consistently correlated with scores on the AMPS across all four groups. These results suggested that strategy use was related to everyday, real-world performance as measured by the AMPS.

In summary, this study served as an example of how theory can inform applied work and how results from the work can in turn provide support to the theory. Using the BMET, which proved to be a good avenue for the analysis of naturalistic strategy use, these results supported the hypothesis that naturalistic strategy use in the ABI population is different than that seen in the healthy population.

Although not a primary focus of this research, the analyses led to the notion that revisions to the task and rule list of the BMET as well as to the administrative and analysis process could be important for future clinical and research work. Also, without lesion data it was not possible to discern whether the differences between stroke and TBI participants were related to their etiology or whether they were reflecting differences in the nature (focal vs. diffuse) or location of the lesion. It is likely that taking into consideration the lesion location and
making the necessary modifications to the BMET assessment, administration procedure and score sheet would lead to more accurate strategy analyses and improved ecological validity.

The results from this study are a first step in improving our understanding of naturalistic strategy use in ABI survivors and how this relates to performance in a real-world situation. This study informs cognitive rehabilitation and can be used to improve strategy training rehabilitation techniques. The results tell us that it is not enough to teach a strategy, it is also important to teach patients how and when to use it for it to be effective. The results obtained here indicate that researching strategy use in ABI survivors provides us with a wealth of valuable information about their performance in an everyday situation. This information can then be used to improve cognitive rehabilitation for ABI patients. Therefore, these results are promising and support the need for future investigation of naturalistic strategy use in this population.
REFERENCES


APPENDICES
1. Buy a birthday card.
2. Buy a lettuce.
3. Buy a brown loaf.
4. Buy a bar of soap.
5. Send an appropriate postcard to:

   P. W. Burgess
   Psychology Dept.
   University College London,
   Gower St.
   London WC1N 6BT

saying Multiple Errands Test, and giving other relevant information.

6. Buy half a pound of apples.
7. Be outside the Travel Agent in fifteen minutes time.
8. Buy a packet of throat pastilles.

You are to spend as little money as possible (within reason) and take as little time as possible (without rushing excessively).
No shop should be entered other than to buy something.
Please tell one or other of us when you leave a shop what you have bought.
You are not to use anything not bought on the street (other than a watch) to assist you.

You may do the tasks in any order.
RELEVANT INFORMATION THAT SHOULD BE ON POSTCARD

1. The name of the shop in the street likely to have the most expensive item.

2. The price of a pound of tomatoes.

3. The name of the coldest place in Britain yesterday.

4. The rate of exchange of the French Franc yesterday.
Appendix B: Simplified version of the Multiple Errands Shopping Test
(adapted from Alderman 2003)

INSTRUCTIONS
In this exercise you should complete the following three tasks:
1) You should buy the following items: small brown loaf, bar of chocolate, packet of plasters, single light bulb, birthday card, key ring.
2) You should obtain the following information and write it down in the spaces below:
   1. What is the headline from either today’s ‘Daily Mail’, ‘Daily Mirror’ or ‘The Sun’ newspaper?
   2. What is the closing time of the library on Saturday?
   3. What is the price of 1 pound or kilogram of tomatoes?
   4. How many shops sell televisions?
3) You must meet me under the clock 20 minutes after you have started this task and tell me the time.

TELL THE PERSON OBSERVING YOU WHEN YOU HAVE COMPLETED THE EXERCISE

Whilst carrying out this exercise you must obey the following rules:
- You must carry out all these tasks but may do so in any order
- You should spend no more than £5
- You should stay within the limits of the upper floor of the shopping centre
- No shop should be entered other than to buy something
- You should not go back into a shop you have already been in
- You should not buy any item from the stalls
- You should buy no more than 2 items in Tesco
- Take as little time to complete this exercise without rushing excessively
- Do not speak to the person observing you unless this is part of the exercise
Appendix C: Hospital version of the Multiple Errands Test (Knight 2002, © Psychology Press, see Copyright Acknowledgement C)

APPENDIX 1:
Instruction sheet given to participants

INSTRUCTIONS
In this exercise you should complete the following three tasks:
1. You should do the following 6 things:
   . Collect something for the examiner from Main Reception and do what is necessary
   . Buy 4 1st class stamps
   . Buy a get well card
   . Buy a can of Coca-Cola
   . Telephone Kemsley Reception and say where you are, who you are, and what time it is
   . Post something to Caroline Knight in Birmingham
2. You should obtain the following information and write it down in the spaces below:
   1. What is the closing time of the staff library on a Friday?
   2. What is the opening time of the hospital shop on a Saturday?
   3. What is the price of a Mars Bar?
   4. How many public carparks are there in the hospital grounds (not including staff or disabled only parking)?
3. You must meet me outside Main Reception 20 minutes after you have started the task and tell me the time.
Tell the person observing you when you have completed the exercise.

Whilst carrying out this exercise you must obey the following rules:
   . You must carry out all these tasks but may do so in any order
   . You should spend no more than £2.50
   . You should stay within the limits of the hospital grounds
   . You should not enter any of the hospital wards or “staff only” areas
   . No building should be entered other than to complete part of the task inside
   . You should not go back into a building you have already been in
   . You should buy no more than 2 items in the hospital shop
   . Take as little time to complete this exercise without rushing excessively
   . Do not speak to the person observing you unless this is part of the exercise

Your examiner was:
Caroline Knight
University of Birmingham, School of Psychology, Edgbaston, Birmingham, B15 2TT.
Appendix D: BMET Participant Package

Instructions

In this exercise you should complete the following three tasks:

1. You should do the following 6 things:
   - Collect something for the examiner* from the Main Information Desk (at the Khedive Entrance) and do what is necessary
   - Buy 4 local stamps (considered 1 item)
   - Buy a birthday card
   - Buy a can of Coca-Cola
   - Telephone Katherine at 416-785-2500 ext.2170 and say where you are, who you are, and what time it is
   - Mail something to Dr. Dawson** at the University of Toronto.

2. You must meet me at the parrot cage 10 minutes after you have started the exercise and tell me the time

3. You should obtain the following information and write it down in the spaces below:
   - What is the closing time of the resident’s library on a Thursday?____________________
   - What is the opening time of the gift shop on a Friday?_____________________
   - What is the price of a Mars Bar?________________________________________
   - How many entrances/exits are there on the main floor of Baycrest?____________

Tell me when you have completed the exercise.

While carrying out this exercise you must obey the following rules:

<table>
<thead>
<tr>
<th>Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>You should carry out all these tasks but may do so in any order</td>
</tr>
<tr>
<td>You should spend no more than $7.50</td>
</tr>
<tr>
<td>You should stay within the limits of the main floor of the hospital</td>
</tr>
<tr>
<td>You should not enter any of the hospital treatment areas or “staff only” areas</td>
</tr>
<tr>
<td>You should not go back into an area you have already been in</td>
</tr>
<tr>
<td>You should buy no more than 2 items in the gift shop</td>
</tr>
<tr>
<td>Take as little time to complete this exercise without rushing excessively</td>
</tr>
<tr>
<td>Do not speak to us unless this is part of the exercise</td>
</tr>
</tbody>
</table>

*Your examiner is:  
**Dr. Dawson  
University of Toronto  
500 University Ave., Suite 160  
Toronto, Ont., M5G 1V7
### Appendix E: Strategy score sheet

<table>
<thead>
<tr>
<th>Task Setting Strategies</th>
<th>Observed (0 or 1)</th>
<th>Frequency Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planned before starting test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Read task/rule list for &gt; 5 seconds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Read map for &gt; 5 seconds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physically oriented self to map or map to self</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drew route before starting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Made notes (other than those required)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task setting type self-talk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organized materials and bag</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Checked watch at start of task</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Went to meeting spot early and waited for examiner</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Got money ready while in line or entering the store/caf</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Went straight to 99cent card rack</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Checked/compared price of card before buying</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Looked at candy rack for price of mars bar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asked examiner questions prior to start point</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asked examiner questions at start point</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task setting type requests for help from staff</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multitasked</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Task Monitoring Strategies

| Checked task/rule list                                                                 |                   |                 |
| Checked map                                                                           |                   |                 |
| Marked tasks as completed                                                             |                   |                 |
| Monitoring type self-talk                                                             |                   |                 |
| Checked watch (first 10 minutes)                                                       |                   |                 |
| Monitored spending                                                                    |                   |                 |
| Looked overtly at signage and visual landmarks                                        |                   |                 |
| Monitoring type requests for help from staff                                          |                   |                 |

**Totals**
Appendix F: Relationships between strategy use and BMET performance (all correlations)

<table>
<thead>
<tr>
<th>Strategies</th>
<th>Stroke n=14</th>
<th>Stroke Control n=13</th>
<th>TBI n=12</th>
<th>TBI Control n=12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total frequency of strategies used</td>
<td>.04</td>
<td>.20</td>
<td>-.71*</td>
<td>.41</td>
</tr>
<tr>
<td><strong>Task Setting Strategies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planned before starting test</td>
<td>-.12</td>
<td>.32↑</td>
<td>.25</td>
<td>.13</td>
</tr>
<tr>
<td>Time spent planning (in seconds)</td>
<td>-.10</td>
<td>.36</td>
<td>.32</td>
<td>.11</td>
</tr>
<tr>
<td>Read task sheet/rule list &gt;5 seconds</td>
<td>.01</td>
<td>-.01</td>
<td>-.14</td>
<td>.53</td>
</tr>
<tr>
<td>Read map &gt;5 seconds</td>
<td>.11</td>
<td>-.01</td>
<td>-.17</td>
<td>.31</td>
</tr>
<tr>
<td>Made notes (other than those required)</td>
<td>.18</td>
<td>.22</td>
<td>-.05</td>
<td>.52</td>
</tr>
<tr>
<td>Task setting type self-talk</td>
<td>-.02</td>
<td>-.17</td>
<td>-.52</td>
<td>-.32</td>
</tr>
<tr>
<td>Checked watch at start of task</td>
<td>.09</td>
<td>.46</td>
<td>.42</td>
<td>.21</td>
</tr>
<tr>
<td>Looked at candy rack for price of Mars bar</td>
<td>.48</td>
<td>.11</td>
<td>.26</td>
<td>.23</td>
</tr>
<tr>
<td>Asked examiner questions prior to start point</td>
<td>.45</td>
<td>-.44</td>
<td>.21</td>
<td>-.06</td>
</tr>
<tr>
<td><strong>Task Monitoring Strategies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Checked task sheet/rule list</td>
<td>-.09</td>
<td>-.02</td>
<td>-.43</td>
<td>.03</td>
</tr>
<tr>
<td>Checked map</td>
<td>.25</td>
<td>.17</td>
<td>-.19</td>
<td>.30</td>
</tr>
<tr>
<td>Marked task as complete</td>
<td>.34</td>
<td>.30</td>
<td>-.38</td>
<td>.54</td>
</tr>
<tr>
<td>Checked watch (first 10 mins)</td>
<td>.30</td>
<td>.38</td>
<td>.45</td>
<td>.35</td>
</tr>
<tr>
<td>Looked at signage and visual landmarks</td>
<td>-.40</td>
<td>-.21</td>
<td>-.71*</td>
<td>-.01</td>
</tr>
<tr>
<td>Monitoring type self-talk</td>
<td>-.18</td>
<td>-.13</td>
<td>-.46</td>
<td>-.37</td>
</tr>
<tr>
<td>Monitoring type requests for help from staff</td>
<td>-.01</td>
<td>-.09</td>
<td>-.56</td>
<td>-.35</td>
</tr>
</tbody>
</table>
Appendix G: Relationships between strategy use and performance on measures of everyday life (all correlations)

<table>
<thead>
<tr>
<th>Measures of everyday life</th>
<th>Stroke n = 14, n(SO) = 14</th>
<th>Stroke control n = 13, n(SO) = 10</th>
<th>TBI n = 12, n(SO) = 9</th>
<th>TBI control n = 12, n(SO) = 8</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total observed</td>
<td>Total frequency</td>
<td>Total observed</td>
<td>Total frequency</td>
</tr>
<tr>
<td>AMPS mot</td>
<td>- .36</td>
<td>- .20</td>
<td>.51</td>
<td>.75*</td>
</tr>
<tr>
<td>AMPS pro</td>
<td>-.68*</td>
<td>-.53</td>
<td>.43</td>
<td>.30</td>
</tr>
<tr>
<td>MPAI adjustment‡</td>
<td>- .34</td>
<td>- .21</td>
<td>-.52</td>
<td>-.33</td>
</tr>
<tr>
<td>MPAI participation‡</td>
<td>-.20</td>
<td>-.15</td>
<td>-.63</td>
<td>-.28</td>
</tr>
<tr>
<td>MPAI SO adjustment</td>
<td>-.06</td>
<td>-.10</td>
<td>-.29</td>
<td>-.22</td>
</tr>
<tr>
<td>MPAI SO Participation</td>
<td>-.29</td>
<td>-.37</td>
<td>-.16</td>
<td>-.23</td>
</tr>
<tr>
<td>DEX‡</td>
<td>-.30</td>
<td>-.16</td>
<td>-.14</td>
<td>.04</td>
</tr>
<tr>
<td>DEX SO</td>
<td>-.17</td>
<td>-.20</td>
<td>.39</td>
<td>.53</td>
</tr>
<tr>
<td>Zoo Map Test</td>
<td>.36</td>
<td>.35</td>
<td>.17</td>
<td>.08</td>
</tr>
</tbody>
</table>
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Author: Caroline Knight, Nick Alderman, Paul W. Burgess

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Publisher: Taylor & Francis

Date: Jan 6, 2002

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