THE USE OF MOBILE PHONES TO COMPENSATE FOR ORGANISATIONAL AND MEMORY IMPAIRMENT IN PEOPLE WITH ACQUIRED BRAIN INJURY

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ABSTRACT

Objectives: To investigate the extent to which people with memory difficulties use cognitive aids, and to compare this with that of the general population. Relationships between current memory aid use, age, and such factors as insight into functional difficulties, and pre-injury use of memory aids were examined. To investigate the usefulness of mobile phones in compensation for memory impairment following TBI; To investigate the impact of the type of memory impairment (encoding vs. retrieval), level of insight, and familiarity with technology on the use of mobile phones as cognitive aids. **Design:** *Study One* – Survey; *Study Two* - Repeated Single-case ABAB-design **Participants:** *Study One* - A group of 29 participants with memory difficulties due to traumatic brain injury (TBI), and an age-matched control group of 33 participants. *Study Two* - Six participants were selected from people with TBI in New Zealand. Inclusion criteria were a history of TBI, being over 16-years-old, and both self-reported and formally assessed memory difficulties. **Measures:** Memory Aids Questionnaire; Patient Competency Rating Scale; Shapiro Control Inventory; Task completion forms. **Results:** *Study One* - People with TBI and controls tended to use a similar number and type of aids. Electronic memory aids (EMAs) were viewed as more effective in assisting with remembering, but were used less frequently than non-EMAs. This study found that age may impact on the type of aids used. *Study Two* - All six participants showed statistically significant improvements in the number of tasks remembered while using the phone vs. not using any aids at all. When comparing the phone and the use of traditional aids, five participants showed statistically significant improvements and one performed worse. These results were maintained at one-month follow-up. While the use of mobile phones to assist with remembering is efficacious in some cases, it is not suitable for use with all individuals.

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INTRODUCTION AND OVERVIEW

Traumatic brain injury (TBI) is a major problem in New Zealand as in other Westernized countries, with approximately 170 people being hospitalized due to head injury per week (Head Injury Society of New Zealand, 2004). Memory impairment is a frequent outcome of TBI, usually receding with recovery time. None the less as many as 75% of people still report difficulty 10 to 15 years later (Thomsen, 1987). Memory is critical to many aspects of personal and social functioning, including taking care of a household, caring for others, and honouring professional and social obligations. All these tasks require forming intentions, delaying their execution until the appropriate time, remembering the intention at the appropriate time, and putting the planned intention into action (McDaniel, Guynn, Einstein, & Breneiser, 2004). Prospective memory or remembering intended actions is particularly vulnerable to TBI, accounting for as much as 50-80% of everyday problems with memory (McCourt, 2002). In an everyday sense, this results in loss of functional independence and extensive personal and financial costs (Hannon, 1995).

Rehabilitation of memory impairments focuses on enhancing the quality of life for injured people and lessening the burden of their family members and support services (McCourt, 2002). While there has been much research on the workings of memory over the last century, research into the rehabilitation of functional memory is in its infancy. It is clear that a restoration approach, utilizing extensive retraining techniques to restore everyday memory (EM) function, has been largely unsuccessful (Godfrey & Knight, 1985; Lezak, Howieson, & Loring, 2004; Prigatano, Fordyce, & Zeiner, 1984). A compensation approach, using internal memory aids such as the use of mnemonics is also deemed of limited use in memory rehabilitation (Fujii, 1996). However, external aids including paging systems, palmtop computers and personal digital assistants (PDAs) have shown considerable promise in assisting functional memory in everyday situations (Hart, Hawkey, & Whyte, 2002; Inglis et al., 2004; Kapur, Glisky, & Wilson, 2004; Wade & Troy, 2001).

A review of previous research such as that conducted by Evans, Wilson, Needham and Brentnall (2003) on the NeuroPage® system (a portable paging reminder system) revealed that while there is widespread use of aids for coping with memory impairment, electronic aids are rarely used. These authors also found that the combination of a number of factors is predictive of the number of aids used after injury: current age, time since injury, number of aids used before, and level of attentional functioning. Furthermore, they found that functional independence increases along with the number of aids used (particularly if six or more aids are used). These aids included wall charts, notebooks, alarm clocks, pagers, and pillboxes. A number of studies investigating the efficacy of a range of electronic memory aids (EMAs) consistently found that the use of electronic aids is related to improvement of functioning. Wade and Troy (2001) found this the case to be with the use of mobile phones, and Wilson (2001) with the use of the NeuroPage®.

The present research was exploratory and had two goals. The first was to investigate the extent and nature of memory aid use, and to identify predictors of successful memory aid use in a group of people with TBI. The second goal was to investigate the efficacy of mobile phones in reducing organizational and everyday memory deficits in people with brain injury.

Both these goals were motivated directly by the example of a single individual, who sustained an extremely severe traumatic brain injury. Two years post TBI and in spite of severe impairment of memory, attention, information processing, visual perception and impulse control he obtained a position in a supermarket as a day-time shelf filler. However, a major problem quickly arose: He would see something that needed replacing on the shelf, but forget what it was by the time he got to the storeroom. Not able to fulfill the very basics of the job and in the face of potential dismissal, he came up with a simple solution: Take a picture of the items to be restocked with his mobile phone, go to the storeroom and review. At the same time he was a cheerful, presentable young man, a real "character" with a sense of humor than endeared him to those around him. That an individual could adapt so well in such a simple way in the face of such impairment was a lesson in what might be possible for others.

Following this, and prior to the commencement of the studies to be reported here, a small scale pilot project was developed, which investigated the extent and nature of mobile phone use within a population with memory impairment. Participants were asked to complete a questionnaire regarding mobile phone and other memory aid use. Further, four people with TBI who had successfully used memory aids were compared to four who had not been as successful. Findings from the pilot informed the research studies that follow in this dissertation and included:

- All of the participants (N=73) used memory aids of some sort, although very few used EMAs except for mobile phones.
- Although 64% owned mobile phones, most were used simply as telephones only, none in an innovative manner such as mentioned above.
- The four people who had used EMAs successfully had difficulties demonstrated on neuropsychological assessment with encoding whereas the four people who had not used EMAs successfully had difficulties with the retrieval of learnt material, had less insight into their difficulties, appeared more apathetic than the EMA cases, and were less familiar with technology than the EMA cases.

In order to provide a context for this study, the causes and mechanisms of brain injury, as well as the pattern of recovery and cognitive sequale of traumatic brain injury are provided in Chapter One. Chapter Two outlines the theoretical models of memory and the existing empirical evidence on everyday memory (EM) and provide a conceptual and operational definition of EM. Chapter Three discusses the rehabilitation of memory and the use of technology in rehabilitation. This is followed by the formulation, methodology, results and discussion of Study One: *The extent and nature of electronic memory aid use* in Chapter Four. The formulation, methodology, results and discussion of Study Two: *Characteristics associated with successful electronic memory aid use* are provided in Chapter Five. A mobile phone prompting system was selected for this study, and the theoretical, technological and practical considerations that impacted on the selection of *Papyrus®* software ultimately used in the present study are discussed. A general discussion of the findings and their implications are provided in Chapter Six. An evaluation of the research including the main contribution and limitations of this research concludes this dissertation.

CHAPTER ONE: ACQUIRED BRAIN INJURY

Introduction

Memory deficits, often in association with other cognitive impairments, result from a wide range of neurological disorders, such as traumatic brain injury (TBI), hypoxic-ischemic events, cerebro-vascular accident, encephalitis and other infectious disorders, toxic exposure, and brain tumours. Each disorder is associated with particular patterns of central nervous system damage, and (overlapping) syndromes of cognitive, behavioural, emotional and physical dysfunction (Sohlberg & Mateer, 2001).

This chapter will focus on TBI as it was the cause of the memory difficulty experienced by the majority of the participants in this study. Hypoxia-hypotensive brain injury will also be covered briefly as it was experienced by a participant in the single-case design study. Mechanisms, cognitive sequale, and factors that contribute to recovery will be discussed.

Effects of Brain Injury

Brain injury occurs in two stages: primary damage, which is the immediate damage to brain tissue that results from organic or mechanical forces; and secondary damage, due to complications that occur as a consequence of the original neuronal damage or from metabolic disturbance (Snyder & Nussbaum, 2002).

Primary Damage

One important dimension of neurological damage is whether a lesion is focal, multifocal or diffuse. Common causes for focal damage include cerebrovascular events (haemorrhage or infarct), neoplasm or tumour, brain abscess, and focal trauma such as penetrating injury, while diffuse injury occurs more frequently after blunt injury such as in accidents.

The extent of focal neurological damage and associated cognitive deficits depends on the site, shape, velocity, and mass of the injury-causing object. A sudden-onset lesion, such as a stroke, in the same location and of similar size to a tumour can have more obvious and devastating effects (Sohlberg & Mateer, 2001).

Multifocal lesions occur due to various pathophysiological or mechanical mechanisms, such as severe cerebro-vascular accidents or TBI. Multifocal lesions typically result in a larger degree of impairment than single focal lesions. This is particularly true when lesions are bilateral and occur simultaneously, rather than unilateral occurring in stages (Sohlberg & Mateer, 2001).

Another dimension to primary damage includes skull fractures with an associated high incidence of intracranial hematoma, and brain contusions and lacerations. Brain contusions are further divided into fracture contusions (occurring at the site of a fracture), coup contusions (occurring at the site of impact in the absence of a fracture), and contrecoup contusions (occurring diametrically opposite to the site of impact), herniation contusions, and intermediary coup contusions (occurring within deep brain structures; Graham, 1995). Neurological damage in the absence of actual head impact such as 'whip lash' injuries, which are associated with traffic accidents can result in gross cerebral contusions (Richardson, 2000). Damage can result from direct impact to the head, such as the head being struck by a rigid surface, or from acceleration-deceleration forces that result in the head suddenly stopping but the brain continuing in the original direction of motion, followed by it rebounding in the opposite direction. Coup contusions often occur as a result of acceleration-deceleration forces. Injury is also caused to the under-surface of the brain as it is forced over the rough bony surface at the base of the skull. Areas most vulnerable are the orbital and lateral under-surfaces of the frontal and temporal lobes. Furthermore, changes to the vascular system result from tearing in the small blood vessels of the meninges and brain surface, leading to extradural and subdural haematomas (Kertesz & Gold, 2003). In turn, the collection of blood in these areas exerts pressure on the brain causing further damage. Damage to the vascular system itself, including torn or damaged arteries, can result in intracerebral haematomas or areas of infarction in which brain tissue is deprived of blood perfusion (Caine & Watson, 2000).

Diffuse Axonal Injury (DAI) occurs when the cause of the injury has the potential to affect widely distributed brain areas. These injuries commonly result from acceleration and deceleration mechanisms such as road traffic accidents, hypoxic-ischemic injury, and various metabolic, infectious, and inflammatory diseases (Fork, et al., 2005). DAI occurs when acceleration-deceleration and rotational forces cause shearing and stretching of neuronal fibre tracts or axons which in turn disrupts electrochemical transmission. The entire cell body dies when an axon is destroyed or sufficiently damaged. Other dependent neurons also die. In addition to physical axonal damage, DAI may result in defective axonal transport and axonal swelling. The overall severity and the functional outcomes of TBI is directly related to the extent of DAI (Fork, et al., 2005). Commonly affected areas include the corpus callosum, the cranial nerves, and the hypothalamic-pituitary system (Richardson, 2000). DAI can result in difficulties with mental speed, attention, cognitive efficiency, and in the case of severe injury complex reasoning and concept formation abilities. Deceleration-related injuries in the frontal and temporal lobes result in problems with activity regulation and control, problem solving, and memory deficits, as well as personality change and difficulties in social adjustments (Graham, 1995).

Secondary Damage

Secondary damage that arises later includes haematomas, brain swelling, raised intracranial pressure, ischaemic damage, infections, and post-traumatic epilepsy (Lucas, 1998). At the time of initial injury surges of excitatory neurotransmitters can create massive neuronal depolarization and the production of free radicals, which further causes damage to the brain (Kertesz & Gold, 2003). Furthermore, ischemia and oedema result from vascular damage. The rupture of small blood vessels and breakdown of the blood-brain barrier can lead to delayed haemorrhages (Kertesz & Gold, 2003). Secondary damage is sometimes a preventable consequence of brain injury, particularly in TBI, and is therefore a critical consideration in the clinical management of the primary cause of the injury. Obstructed airflow during an accident or assault can result in irreversible anoxic brain injury. Brain regions vulnerable to anoxic damage include the hippocampus, and more frequently the watershed cerebral cortex and basal ganglia. The most frequent consequence of damage in these areas is memory disturbance. This is followed by disturbances in behaviour and personality, visuospatial impairment, and combined memory and other cognitive difficulties (Hopkins, 2005).

Ischemia/hypoxia refers to a partial deprivation of oxygen to the brain, whereas anoxia refers to a total deprivation of oxygen to the brain for a period of time. Brain tissue remains viable and recovery of function is rapid in cases of where the ischemic tissue has sufficient collateral supply or blood flow is restored within an appropriate time limit. However, brain tissue is damaged or dies after several minutes of deprived blood supply. These events occur in instances where people lack normal cardiac or respiratory function, or where there are blockages in supply such as embolism (Hopkins, 2005).

Although generalized damage typically results from hypoxic and ischemic events, the hippocampus is highly vulnerable to hypoxic-ischemic insult, resulting in significant memory impairments including amnesic syndromes and anterograde memory disorder (Cummings, Tomiyasu, Read, & Benson, 1984; Kuwert et al., 1993). Severe amnesic syndromes can also occur in some people with TBI, particularly when there has been a period of anoxia or hypoxia. Memory disorder is often the most pronounced cognitive deficit and recovery occurs over a much longer time frame than recovery from most brain injury events. Provided that other cognitive functions are relatively intact, people with hypoxic or ischemic damage can learn and effectively use strategies to compensate for memory impairment. Behavioural difficulties including apathy, inertia, and impulsivity are more difficult to treat (Hopkins, et al., 2005).

Causes of traumatic brain Injury

The main causes of traumatic brain injury are road accidents, falls and assaults. A male is 2 to 3 times more likely to sustain a TBI than a female (Krans & Chu, 2005). Motor vehicle accidents contribute predominantly to severe and fatal TBI, whereas all other causes of mild to moderate TBI vary between countries, cities, and different socio-economic areas within cities (Asikaiken, 2001). For example, mild to moderate TBI caused by road traffic accident varies from 24% in Scotland to 90% in Taiwan, and the proportion TBI caused by assault ranges from 1% in France to 45% in inner city Johannesburg (Asikainen, 2001). One consistent finding across countries is that the 15 to 24 year age group is most affected by TBI, regardless of the cause of injury. Sixty-four percent of all road accidents occur in this age group (Tate, McDonald, & Lulham, 1998). Assaults are also a major contributor to head injury in this age group, particularly within lower socio-economic areas (Asikainen, 2001). In contrast, falls contribute to as much as 76% of brain injury in children and the elderly (Fraser, Glass, & Leathem, 1999; Tate et al., 1998).

As discussed above, TBI occurs most often in young males, regardless of the cause of injury, with motor vehicle accidents accounting for 64% of brain injury in the younger population. The use of mobile phones in this population is prolific, adding to the credibility of their use as cognitive prostheses following brain injury. Training in the use of electronic aids can be enhanced if the particular type of technology is already familiar to a client (Wright et al., 2001).

Levels of Severity

Two ways to measure severity of TBI are Loss of Consciousness (LOC), or the duration of unconsciousness or unawareness following brain injury, and Post Traumatic Amnesia (PTA), or the duration of acute memory disturbance following brain injury. PTA is a specific type of anterograde amnesia. It includes the period of coma and extends to the time at which the patient reliably, consistently and accurately regains memory for ongoing events. The Glasgow Coma Scale (GCS) (Teasdale & Jennet, 1974) is also commonly used to document severity using observation of eye opening, best motor response, and best verbal response to determine the degree of and measure changes in the level of coma. Scores range from 3 to 15, with scores of 8 or less reflecting severe injury, 9-12 moderate injury, and 13-15 mild injury. The GCS is presented in Table 1.

Table 1
Glasgow Coma Scale (GCS). (Teasdale & Jennet, 1974).

	Points
Eye opening	
Opens eyes on own	4
Opens eyes on request	3
Opens eyes in response to painful stimuli	2
Does not open eyes	1
Best motor response	
Follows request to move	6
Pushes painful stimulus away	5
Withdraws from painful stimulus	4
Has abnormal (decorticate) flexion	3
Has abnormal (decorticate) extension	2
Makes no motor response	1
Verbal response	
Converses and is orientated	5
Confused speech or disoriented	4
Uses words but doesn't make sense	3
Makes only sounds or incomprehensible words	2
Makes no noise	1

The Galveston Orientation and Amnesia Test (Levine, O'Donnell, & Grossman, 1979) measures levels of functioning during PTA. It is used to evaluate orientation to person, place, time and circumstances. Orientation to person is typically the first to stabilize, followed by orientation to place and circumstances, and lastly orientation to time (Sohlberg & Mateer, 2001).

Based on the rating scales above, severity of TBI can be placed on a continuum from mild to severe, reflecting very mild concussions to catastrophic injuries resulting in severe disability or death. Mild TBI is defined as an injury causing

PTA lasting one hour or less and LOC of 20 minutes or less (McAllister, 1994). These people generally achieve a GCS score of between 13 and 15. Moderate TBI is defined as an injury with a PTA ranging between one to 24 hours, LOC of less than 6 hours, and a GCS of between 9 and 12. Severe TBI has a PTA exceeding 24 hours, LOC exceeding 6 hours, and a GCS of less than 9 (Tate et al., 1998). Levels of severity based on LOC, PTA and GCS score are displayed in Table 2.

Table 2
Classification of severity of TBI (Tate et al., 1998)

TBI Classification	GCS score	LOC duration	Length of PTA
Mild	13-15	20 minutes or less	60 minutes or less
Moderate	9-12	Less than 6 hours	1-24 hours
Severe	3-8	Over 6 hours	Over 24 hours

Retrograde amnesia (RA) refers to memory loss for events leading up to an accident and for the accident itself. RA for events immediately leading up to an event resulting in brain injury is common. Information leading up to the event remained in short-term memory and was not yet consolidated into long-term memory. RA is temporary and remote memories of life events gradually return up to the period just preceding the brain injury causing event. Recent memories are more affected than memories for early life events. Retrograde amnesia may represent difficulties with time tagging and source memory, rather than actual loss of remote memory (Kapur, 1999).

Cognitive Sequale

Although people with first time mild TBI recover to near normal memory functioning within one month after an injury, many continue to have complex cognitive difficulties. These include impaired concentration, distractibility, forgetfulness, and focussed, sustained, alternating, divided, and selective attention (Mateer & Raskin, 2000). In addition to these difficulties, people with moderate to severe TBI have attention deficits at the most basic levels, including arousal and focussing of attention (Mateer & Raskin, 2000; McAllister, 1994). Impairments related to focal damage may include symptoms specific to the area of damage, e.g., aphasias with left sided damage (Richardson, 2000). However, the structures most at risk from acceleration-deceleration injuries are the ventral and lateral surfaces of the frontal and temporal lobes, resulting in impairment with attention, memory and learning, problem-solving, planning, initiation, impulsivity and self-regulation, and self-awareness. Attention difficulties usually include deficits in shifting mental set and dealing with distraction. Although long-term memory remains intact, learning and the retention of new information are largely impacted upon (Neath & Surprenant, 2003; Ownsworth & McFarland, 1999)

Of the post TBI cognitive difficulties, memory impairment is the most enduring (Ownsworth & McFarland, 1999; Quemada et al., 2003). The degree of memory impairment varies according to the site and severity of the insult (Mateer & Raskin, 2000). For example, people with moderate to severe TBI perform worse than those with mild TBI or no TBI controls on Logical Memory (WMS-III), and the Rey Auditory Verbal Learning Test, including recall after 5 word-list presentations, retention after distraction, and recognition (Raskin, 2000b). Those with severe TBI have difficulties with episodic memory, or the experiential knowledge of events (Snyder & Nussbaum, 2002), as well as prospective memory deficits even when highly salient retrieval cues are available. These deficits persist one-year post injury (Schmitter-Edgecombe & Wright, 2004). Moderate to severe TBI also results in a severe persistent memory impairment that leads to inefficient encoding strategies, in the absence of memory consolidation deficits (Hart, 1994). Permanent attention, memory, and planning deficits are expected in severe TBI, and functional and vocational rehabilitation is compromised in this group (Asikainen, 2001). People with TBI also frequently experience difficulties with Working Memory (WM), or the ability to hold information in memory and manipulate this information effectively (Gilandas, Touyz, Beumont, & Greenberg, 1984; Quemada et al., 2003).

Information processing speed is also often significantly slowed following TBI (Flemming, Baguely, & Green, 2004) impacting on higher level functions including attention, memory, and executive functioning. This in turn impacting on rehabilitation outcomes. For example, Asikainen (2001) found performance on the Stroop Color Word Test and Purdue Pegboard test, which both measure information processing speed among other abilities, differentiate between TBI patients that are capable of employment and those who are not.

Executive functions refer to those cognitive abilities involved in the initiation, sequencing, organization, and monitoring of behaviour, including planning, problem-solving, and mental shift abilities (Lezak et al., 2004). Problems with executive functioning are also common consequences of TBI, e.g., difficulties with goal achievement, multi-tasking, or sequencing the steps necessary to complete a task, which occur despite intact intellectual functioning and information recall (Raskin, 2000a). The integrity of the prefrontal cortex and frontal lobes, which are believed to be primarily responsible for executive functioning, impacts on memory functions and personality changes often seen in TBI. Awareness of cognitive deficits, inappropriate behaviour, social cues, or affective appearance may also be impaired in people with TBI (Raskin, 2000a).

Emotional and psychological adjustment following a brain injury impacts on recovery outcomes. Lack of self-awareness poses a challenge to rehabilitation efforts, is associated with poor self-monitoring and poor behavioural self-regulation (Flemming, Strong, & Ashton, 1996). These factors limit personal and social adjustment, and reintegration into community and vocational activities (Asikainen, 2001). Acceptance of and emotional responses to changes in cognitive functioning and personality impact greatly on people and their families, and pose a particular challenge to cognitive rehabilitation (Kit, Mateer, & Graves, 2007).

The cognitive and emotional difficulties described above impact severely on the ability to function in everyday life. The ability to process information is slowed, and attentional resources are overloaded. The ability to filter information, particularly in the face of distraction is reduced. In addition, primary memory impairments add to difficulties in remembering and organising daily activities.

Patterns of Recovery

Sohlberg and Mateer (2001) suggest that recovery from severe TBI typically follows a characteristic pattern: The first phase involves the time of the accident and shortly thereafter. There is usually a period of unconsciousness, and interventions are focussed on securing survival and reducing secondary damage. Treatment includes medical, surgical, and pharmacological interventions, and palliative care including nutrition, skin care and minimizing secondary disabilities.

The second phase occurs within four weeks after the accident, when people spontaneously open their eyes and develop a sleep-wake cycle. They may still experience a reduced state of awareness and understanding of their circumstances, and do not have any purposeful behavioural responses. Although responsiveness gradually increases, speech, movements and behaviours appear erratic. Automatic or reflexive responses to visual stimuli and orienting to auditory stimuli increase. These responses gradually come under volitional control. Restlessness and agitation is common during the second phase of recovery. The patient may demonstrate confusion, disorientation, severe attentional deficits, disinhibition, and severe memory loss. Patients are typically still in PTA. Intervention is focussed on reducing environmental stimuli.

The third phase of recovery starts when acute medical recovery may largely have occurred as much as possible. The true nature of cognitive difficulties is revealed, leading to a long process of understanding, accepting and compensating for them. This phase is often neglected, and relatively few outcome studies exist to support the efficacy of interventions.

The third phase involves the restoration of orientation and continuous memory. Significant memory deficits and impaired new learning may persist. The length of this phase is determined by the severity of the injury. Intervention is focussed on the stabilization of self-care activities and supporting the recovery of cognitive functions. This includes efforts to stabilize orientation, improve effective communication, and learn the use of compensatory strategies to counter residual cognitive difficulties. Rehabilitation should continue to assist with decision making, self-care activities, reengaging in leisure and social activities, social skills training, and to support emotional regulation. Rehabilitation efforts are most effective if they are tailored to individual needs (Wilson, 2002)

The Rancho Los Amigos Levels of Cognitive Functioning Scale and the Stages of Recovery from Diffuse Axonal Injury Scale are useful in identifying and monitoring these stages of recovery from TBI. Both scales track progression through the various stages of recovery and are useful for alerting rehabilitation professionals to behaviours indicative of recovery, decline, or levelling of symptoms. These scales are depicted in Tables 3 and 4 respectively.

Table 3
The Rancho Los Amigos Levels of Cognitive Functioning Scale (Sohlberg & Mateer, 2001).

1.	No response
2.	Generalized response
3.	Localized responses
4.	Confused-agitated
5.	Confused-inappropriate
6.	Confused-appropriate
7.	Automatic-appropriate
8.	Purposeful and appropriate

Recovery from brain injury is influenced by a range of variables, including demographic variables or non-injury related factors, injury related factors, psychological factors, and neuroplasticity and synaptic reorganization mechanisms (Sohlberg & Mateer, 2001). These are discussed below.

Table 4
The Stages of Recovery from Diffuse Axonal Injury Scale (Mills, Cassidy, and Katz, 1997, p. 116).

1.	*Coma*
	Unresponsive
	Eyes closed
2.	*Vegetative state*
	No genitive responsiveness
	Gross wakefulness
	Sleep-wake cycles
3.	*Minimally conscious state*
	Purposeful wakefulness
	Responds to some commands
	Often mute
4.	*Confusional state*
	Recovered speech
	Amnesic (PTA)
	Severe attentional deficits
	Agitated, hypoaroused, and /or labile behaviour
5.	*Postconfusional, evolving independence*
	Resolution of PTA
	Cognitive improvement
	Achieving independence in daily self-care
	Improving social interaction
	Developing independence at home
6.	*Social competence, community re-entry*
	Recovering cognitive abilities
	Goal-directed behaviours, social skills, personality
	Developing independence in the community
	Returning to academic or vocational pursuits

Factors contributing to recovery

Non-injury factors that contribute to outcome include age at the time of injury, the level of premorbid intelligence and pre-injury education, (Asikainen, 2001), socio-economic status (Tate et al., 1998), and premorbid or current substance abuse (Barnfield & Leathem, 1998).

Both ends of the age spectrum are more susceptible to the effects of brain injury and associated long-term disability than other ages. Injury in early life is related to severe deficits, particularly if the injury resulted from prenatal injury, diffuse injury, or early injury to particular regions of the brain. Recovery from early focal injury may be enhanced by a young age. However, infants are very susceptible to damage from subdural haematoma, which result in massive cell loss and severe lasting disability. Infants with bilateral diffuse hemispheric hypo-density also have a poor prognosis with difficulties including blindness, and remaining nonverbal and non-ambulatory long after the injury (Hannon, 1995).

Early injury impacts on the acquisition of motor, cognitive, social and linguistic skills. Recovery is enhanced when the cortical networks for a particular skill have already been established (Henry, et al., 2004). Advanced age and a lack of involvement with technology may result in poorer outcomes for elderly TBI patients. Normal aging result in cerebral volume reduction, blood flow reductions, and neuronal loss with shrinkage occurring mostly in the frontal region. It is also this region that is most vulnerable to TBI. Advanced age and TBI result in an additive effect on cognitive impairment. However, older adults are in a more stable lifestyle, with fewer life demands and possibly greater support than young adults, which aid rehabilitation efforts (Richardson, 2000).

Premorbid intellectual functioning and educational level are predictive of recovery outcome, with a senior high school or university education being most predictive of positive outcomes (Asikainen 2001). This is consistent with the view that the level of pre-injury learning impacts on the level of impairment. Autopsies performed on the brains of university graduates found more dendritic material than those with a high school qualification, which in turn had more dendritic material than those with lower levels of education (Sohlberg & Mateer, 2001). (This may of course only reflect that more capable people continue with higher education). Recovery from brain injury may also be related to premorbid learning ability, motivational factors, higher social economic status, larger support systems, and better access to rehabilitation services, than those with lower levels of education.

Brain injury is also associated with socio-economic status (SES) with low SES being related to greater risk of brain injury resulting from assault and already compromised learning strategies, and a high incidence of substance abuse, which also contributes to the occurrence of road accidents, falls, and assault. Alcohol intoxication at the time of injury is also associated with lower recovery rates (Asikainen, 2001; Tate et al., 1998).

Injury related variables include the time since injury, and the extent and severity of the injury. The rate of recovery is typically faster over the initial stages of recovery and plateaus during the later stages of recovery. Recovery from moderate to severe injury is rapid during the first six months, and slows over approximately the next two years, after which recovery is slower and less significant (Kertez, & Gold, 2003). For mild TBI, recovery occurs rapidly over the first three to six months with most symptoms resolved by 12 months for 85% of those affected. These differences can be explained by diaschisis, or a process during which the depression of remote structures occurs due to their connections with a lesioned area. The undamaged remote areas form new connections with other undamaged areas or adjust to lack of input from the lesioned area. Furthermore, recovery from non-specific factors such as oedema aid early recovery (Sohlberg & Mateer, 2001).

People with focal injury recover more rapidly than those with diffuse injury. However, this depends on both the size and the location of the focal lesion. For example, impairment from a small lesion in a critical brain region can be profoundly debilitating or even fatal. Recovery from small lesion is typically supported by neuronal reconnection, whereas recovery from larger lesions or diffuse damage is related to compensation and behavioural adaptation (Walsh, 1991). A previous injury also increases the risk for subsequent brain injury by over 30%, resulting in a cumulation of damage and associated functioning (Richardson, 2000).

Neuroplasticity and synaptic reorganization have specific implications for rehabilitation. For example, it is unclear whether compensatory strategies will support or inhibit functional reorganization, or the recruitment of remote neural circuits to aid for particular behaviours to occur (Kertez, & Gold, 2003). This will theoretically impact on the most advantageous timing of rehabilitation efforts. For example, early rehabilitative efforts may suppress functional reorganisation by supporting competitive functions rather than allowing time for remote neural circuits to assume responsibility for the lost function (Nelson, & Luciana, 2001). However, compensation on a neurological level may aid recovery by allowing modification of synaptic connectivity, or the development of new dendrites to receive information from a different neuron in the same circuit, or from a more distant circuit. Furthermore, enhanced recovery of neuro-behavioural function is associated with early environmental stimulation. This is related to early sensory stimulation to encourage neuronal connectivity in partially disconnected neuronal circuits. Although recovery of function is less supported by current research than compensation for lost function, the knowledge of brain plasticity support the role of both restitutive and compensatory rehabilitation approaches (Nelson, & Luciana, 2001).

Summary

Cognitive deficits result from a wide range of neurological disorders and causes of injury. Recovery varies according the type, extent, location, and severity of damage sustained, but typically follows a pattern of recovery that occurs in three stages. The present research focuses on rehabilitation in the last stage of recovery, when cognitive deficits become salient. Due to the high incidence of TBI-related EM problems, the present study focuses on this consequence of traumatic brain injury. EM deficits place large financial and emotional demands on people who have sustained TBI, as well as on their families and rehabilitation resources. The following chapter provides further investigation into memory.

CHAPTER TWO: EVERYDAY MEMORY

Introduction

The following sections provide an overview of the theoretical divisions of memory, the stages of memory processing followed by in-depth consideration of the theoretical structure of everyday memory and prospective memory which are the focus of the current study.

Memory Fractionation

Short-term Memory (STM)

Early views of STM held that it provides temporary storage of information that is later consolidated into long-term memory (LTM). The contemporary view is that it also has a role in working memory allowing information to be temporarily attended to or worked with (Kalat, 1998).

Working memory comprises three theoretical components. The first, the central executive, directs attention to particular environmental stimuli and determines which items are stored in working memory. Both the phonological loop that stores auditory information by means of sub-vocal speech, and the visuospatial sketchpad that stores visual and spatial information assists the central executive (Baddeley, 1995).

The episodic buffer is a proposed component of STM, and is theorized to provide a temporary multimodal store that integrates information from the other STM subsidiary systems with those of LTM. The episodic buffer accounts for the ability to utilize prior knowledge in order to enhance the storage and retrieval of new information (Baddeley, 1995). Hebb's early theory depicted short-term memories as reverberating circuits of neuronal activity that, if active for long enough, would result in permanent structural or chemical change in the brain (Nelson, & Luciana, 2001). It is now considered that the emotional content is of more importance in memory consolidation than the length of time of neuronal activity (Kalat, 1998). These stages of processing are illustrated in Figure 1.

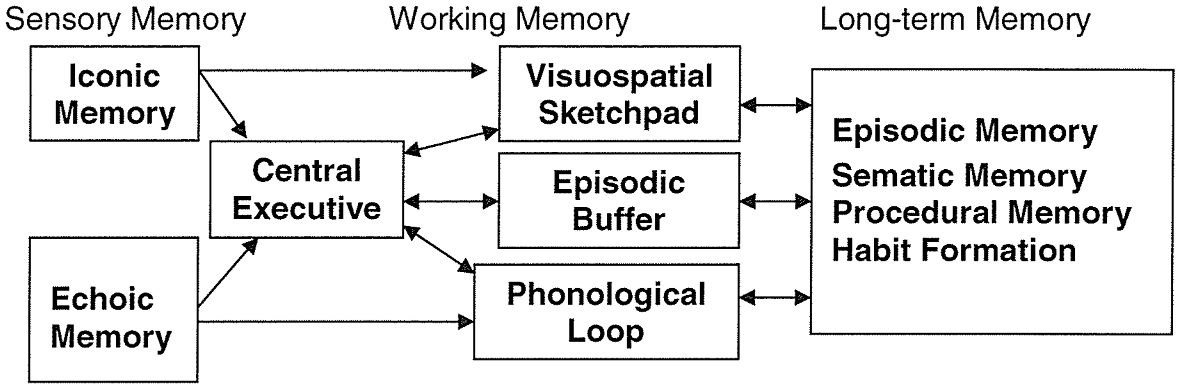


Figure 1. Representation of the memory system (Adapted from Torgensen, 1996).

The primary function of STM is encoding, which involves transforming sensory information into perceptual or conceptual mental representations (Torgensen, 1996). The capacity of STM is limited and a number of factors determine whether the memory-trace will be consolidated into LTM or not, such as emotional impact, length of time spent rehearsing, and organization of new information, as well as integration with prior knowledge (Kalat, 1998).

Long-term Memory (LTM)

The major divisions within LTM are between declarative, or explicit, and non-declarative, or implicit, memory. Declarative memory can be sub-divided into memory of facts (semantic memory) and memory of events (episodic memory). Skills and habits, priming, classical conditioning, and non-associative learning are all thought to contribute to the structure of non-declarative memory (Baddeley, 1995). Storage and subsequent retrieval are LTM processes.

The storage of information requires neurochemical changes in neurons, neurochemical changes of the synapse, elaboration of dendritic neuronal structures to increase contact with other cells, and possible apoptosis, or programmed cell death, of redundant connections (Lezak et al., 2004). Although many brain structures and regions are likely contributors to memory, hippocampal and medial temporal lobe processing are thought to be critical to the transfer of information to the neocortex for long-term storage (Kapur & Brooks, 1999, cited in Lezak et al., 2004).

Stored information is retrieved either directly in the case of declarative memory, or indirectly in the case of non-declarative memory. Retrieval impacts on subsequent memory performance and takes the form of either recall or recognition. LTM performance is influenced by the frequency, and semantic associability of information (Baddeley, 1995). The prefrontal cortex and the parietal cortex play a role in episodic retrieval, and the medial temporal lobe regions are sensitive, and possibly contribute to retrieval attempts (Rugg, 2002).

The non-declarative memory system may be preserved after brain injury, and reliance on this system can aid learning of new procedures such as using electronic memory aids (Sohlberg & Mateer, 2001), particularly if the individual has a high level of premorbid familiarity (procedural memory) with the device.

Conceptual Definition of Everyday Memory

Ellis and Kvavilashvili (2000, p.1) define EM as "...the skills required to support the fulfilment of an intention to perform a specific action in the future". Thus EM is the real world manifestation of facets of memory. EM comprises two components: Prospective and Retrospective memory.

Prospective and Retrospective memory

The first component of EM, prospective memory, can be conceived as our ability to remember to do something in the future, whereas the second component, retrospective memory, involves remembering the content of the intention and the context in which the intention is to be executed (Cohen, Dixon, Lindsay, & Masson, 2003). According to Burgess, Quayle, and Frith (2001) prospective memory is comprised of the connections among goal directed intentions and wishes, and the actualisation of these plans at the appropriate time and in the appropriate context. Without prospective memory, continued verbal rehearsal of an intended task would be necessary until such time or context in which the task is to be executed occurs. For example, with impaired prospective memory, one would have to continually rehearse intentions such as taking medication at the appropriate time, or attending an appointment at a future date. This would not only limit available resources that are needed for other mental activity, but reduce the individual's level of functioning overall. In contrast to retrospective memory, the retrieval of prospective memory tasks at the appropriate time and place, does not rely on external prompts, but on self-initiated retrieval processes (Schmidt, Berg, & Deelman, 2001).

There is some disagreement in the literature on the exact nature of prospective memory. Burgess, Veitch, Costello and Shallice (2000) conceive prospective memory as a cognitive process necessary to coordinate and execute multiple tasks, whereas Ellis (2000) sees prospective memory as a cognitive process that underlies the realization of delayed intentions and their associated execution. Crowder (1996) and Roediger (1996) criticize the use of the term prospective memory altogether, and view it as nothing but a new way of studying explicit episodic memory. In the current study prospective memory viewed as a distinct type of episodic memory that is related to explicit episodic retrospective memory. Support for this view is provided below.

The core process of prospective memory is the reinstatement of an intention (Burgess et al., 2000). Prospective memory tasks are structurally similar to other memory tasks, which include a study, retention, and test phase that relies on the presentation of a cue (Graf & Uttl, 2001). Furthermore, the prospective functions of memory may be divided into sub-domains (i.e. episodic and semantic memory) that are analogous to the divisions in retrospective memory (Graf & Uttl, 2001). However, it is acknowledged that such divisions are not yet empirically supported. The major conceptual division underlying the assumption that prospective memory and retrospective memory are distinct forms of memory is the manner in which cues are utilized. In prospective memory tasks cues are *to be* recognized signals that are used to recall a previously formed intention. Once cue discovery is achieved, the task becomes retrospective with the retrieval of the content and context of the intended action. For example, the intention to buy grocery items on the way home from work may become apparent when driving past the store. The intention was formed before going to work, and attention was focussed on other activities during the work day. This plan is recognized in the presence of the appropriate cue, the store. Retrospective memory uses this cue and engages in the recovery of previous episodes, events, and experiences, for example recollecting which items to buy from the store and where these items are located in the store. In prospective memory the cues are embedded in other ongoing tasks and situations, whereas in retrospective memory cues are consciously used to retrieve information after being alerted to the relevance of the cues. Furthermore, prospective memory impairment can occur in the absence of retrospective memory impairment. For example, an individual with prospective memory difficulties may fail to recognise the reinstatement of an intention such as buying an item from the shop upon the presentation of a cue, while still being capable to utilize retrospective memory to recall the particulars of a shopping experience. Prospective memory is therefore a necessary part of the process of remembering an intention; of which retrospective memory is a related second component.

In TBI both prospective memory and retrospective memory deficits impact on the ability to remember to remember, and what to remember. The use of mobile phones in the present research targets both prospective memory and retrospective memory, by providing a salient cue that there is a planned task, and exactly what the task is.

Kliegel, Eschen, and Thöne-Otto (2004) suggest that EM involves a complex process that occurs during at least four phases. Phases one to three involve prospective memory, and phase four requires retrospective memory.

Phase one involves intention formation. For example, a plan of action, including the tasks involved and the timing of intended actions, is formed. The plan is then encoded. Prospective memory deficits may result from a range of problems related to encoding. For example, problems in comprehension or auditory perception may lead to encoding difficulties.

Phase two, the intention retention phase, necessitates keeping the intention in mind, whilst attending to other tasks (Kliegel, Eschen, & Thöne-Otto, 2004).

Memory deficits may result from interference or from information extinguishing, despite sufficient encoding.

The intention reinstatement phase, or phase three begins once the intended time or context for the intended action arises. Inhibition of other ongoing activities is required and the intended plan is reinstated. Deficits in monitoring the environment for time- or event-based cues may result in memory difficulties. The saliency of cues also impacts on the efficiency of memory during this phase. Mobile phones can overcome encoding deficits by people entering (encoding) the intention on the device, storing the information on the phone until it is needed, and the phone providing a salient cue at the appropriate time, as well as the content of the intended action.

The fourth phase of prospective memory processing proposed by Kliegel et al. (2004) is the intention execution phase, which requires the initiative to carryout the action as intended. Retrospective memory deficits may result in forgetting the planned actions required to execute the intention. A range of other neuropsychological problems, including executive dysfunction and apathy, may compound problems in execution, such as making it difficult to return to complete an intended task, once interrupted. An additional phase suggested by Thöne-Otto and Walther (2003) involves evaluation of the recall situation, and extinguishing intentions from memory. Failure in this stage will result in perseveration even if the intended task has been successfully executed.

Executive Functioning

Executive functioning is presumed to be responsible for the prospective component (initiating a response at the appropriate time), whereas the retrospective component is viewed as a 'classical' memory function (remembering the presence and content of an intention), (Kopp & Thöne-Otto, 2003). Those with impaired executive functioning post TBI perform worse whilst executing prospective memory tasks than patients with retrospective memory difficulties. This supports the view that executive functioning plays a critical role in the formation, retention and reinstatement of intentions (Kopp & Thöne-Otto, 2003). This view is further supported by the finding that executive functioning predicts performance on time-based, event-based, and multi-task prospective memory tests (Martin, Kliegel, & McDaniel, 2003). Executive functioning deficits can be overcome while using a mobile phone by supporting the planning phase by making the intentions explicit, and converting those to time-based tasks.

Vigilance

Prospective memory is not needed in all instances where an intention needs to be executed. For example, prospective memory is not a necessary component of intention fulfilment in vigilance tasks. Vigilance and prospective memory are differentiated by the utilization of attentional resources during these tasks, as well as by the level of conscious awareness needed to attend to cues during these tasks (Ellis & Kvavilashvili, 2000). In vigilance this involves actively attending to and maintaining the intention in mind. Vigilance can be conceived as short-term prospective memory. All attentional resources are directed to the intention, and awareness is dominated by the expectation of a cue to initiate the intended activity. For example, a 100m sprinter in the starting block has a high level of awareness of the intention to run the race, all attentional resources are directed towards performance, and the cue or starting shot is the expected cue to start sprinting (Ellis & Kvavilashvili, 2000).

In contrast, prospective memory proper can be viewed as long-term prospective memory. Following the formation of an intention, thoughts and attentional resources are directed to other ongoing activities. Furthermore, there is no conscious expectation that a cue will be presented as to alert to the intention. An example might be to buy running shoes the next time one goes shopping. Vigilance and prospective memory can be viewed as a continuum of possible prospective memory functions. Figure 2 depicts a conceptual model of this continuum. On the one end working memory and conscious awareness is dominated during the retention interval, whereas on the prospective memory proper end the intention is no longer held in working memory. Conscious awareness is focussed on competing activities during the retention interval.

Habitual remembering

Prospective memory is unnecessary during habitual remembering. Habitual tasks are integrated in routine activities that occur as sequences of actions. The execution of an activity is initiated as part of a chain of well-learned events and not on the recognition of surreptitious cues (Ellis & Kvavilashvili, 2000). For example, taking medication at the same time every day and checking the mailbox upon arriving home everyday are instances of habitual remembering. However, performance on these tasks is also impaired in people with TBI. For the purpose of the current study habitual remembering is considered as a sub-domain of EM, and habitual memory tasks were included in the study as outcome measures.

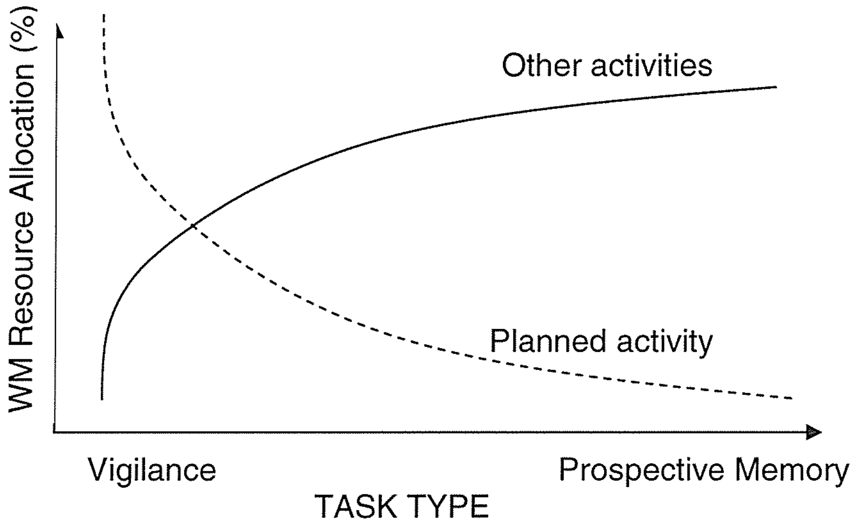


Figure 2. A conceptual model of resource allocation for vigilance and prospective memory tasks (Graf & Uttl, 2001, p3.).

Metamemory

Metamemory, or people's understanding and awareness of their own memory function, is a critical aspect of EM. Awareness of personal strengths and weakness, including memory functioning, impacts on behaviour. People with EM impairment may lack an understanding of what actions may be necessary to mitigate their memory problems. They may also have an altered sense of knowing, or impairment in knowing how accurate their knowledge is, as well as how likely they are to accurately recognise what they know. For example, people with unimpaired metamemory have knowledge that if they have forgotten particular information, such as the title of a book they have read, they would recognize it (Sohlberg & Mateer, 2001). Impaired self awareness extends beyond memory, and is a common neurobehavioural deficit in people with TBI, who tend to overestimate their cognitive, social and emotional functioning. Poor insight has been associated with poor employability outcomes and low motivation for treatment (Sherer, Hart, & Nick, 2002). A conceptual map of EM memory was developed based on the theories outlined above. This map is depicted in Figure 3, and includes the sub-domains of habitual remembering and metamemory (solid lines), as well as other cognitive processes needed for the memory of everyday tasks (dotted lines).

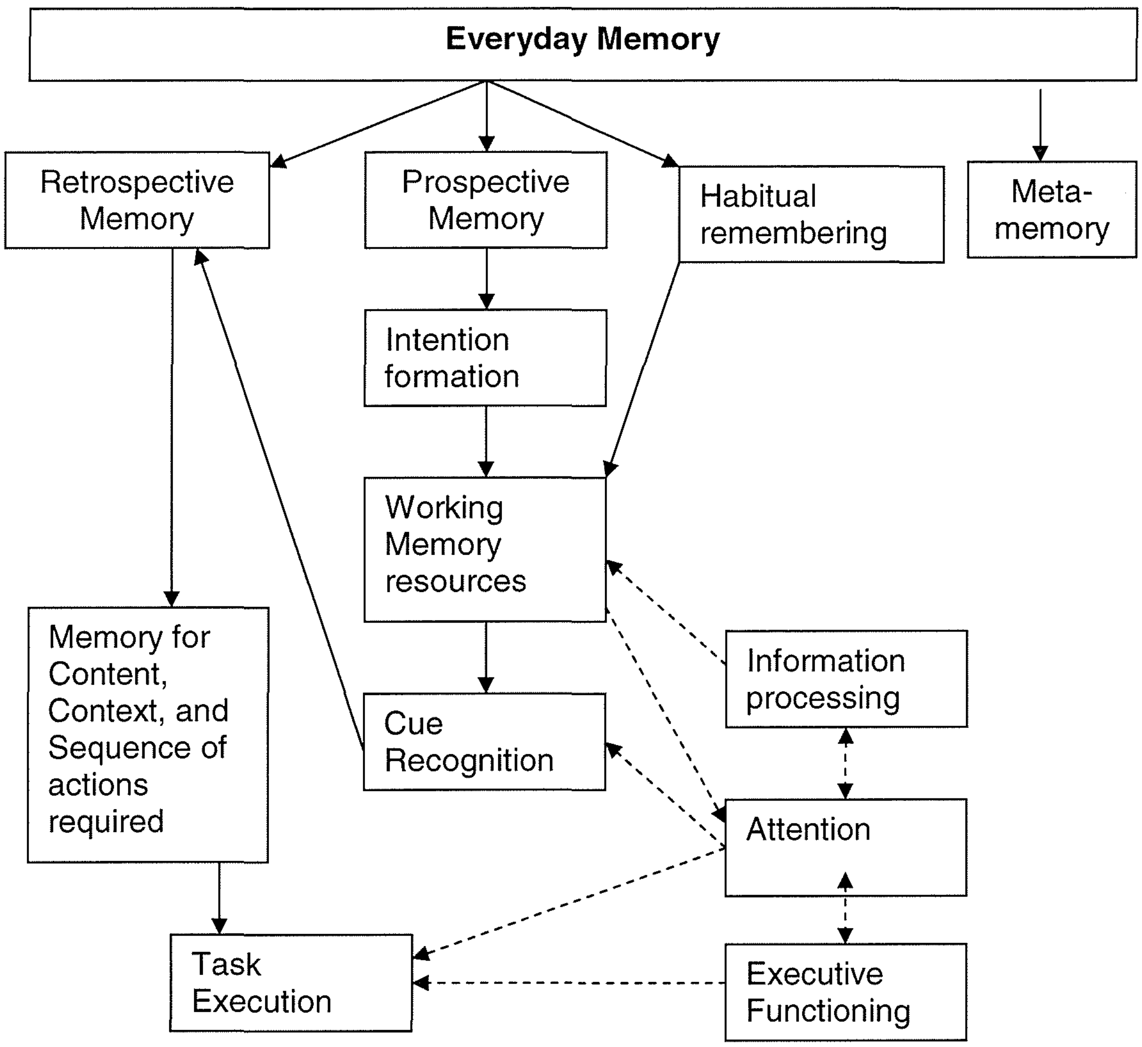


Figure 3. A conceptual map of everyday memory.

The present research is concerned with the rehabilitation of EM deficits, and therefore focuses on both the prospective and retrospective components of EM. EM is defined as forming the intention to do something, shifting attentional resources away from the intention, remembering the intention in the designated context following the presentation of the appropriate cue, and remembering the content of the intention. The execution of an intention relies on additional factors including intact executive functions such as planning and initiation, and the opportunity to fulfil the intention (Burgess, Quayle, & Frith, 2001), as well as metamemory. The conceptual definition guiding the present work conceives EM tasks as comprising both one-off episodic prospective memory tasks, and habitual memory tasks.

Self-efficacy

Self-efficacy is defined as the degree of confidence in one's own abilities to exert control over self and environment to reach a specific goal. It can be conceptualized as a personal factor that influences health and well-being (Levin, Ilgen, & Moos, 2007). Moos and Holanhan (2003) noted that the relationship between self-efficacy and health outcomes is moderated by cognitive appraisals and specific coping responses or skills. For example, overestimations about symptoms that occur following mild traumatic brain injury, including memory deficits, and underestimations of the normal prevalence of certain symptoms, result in these everyday physical and cognitive difficulties being attributed to the head trauma. These expectations may produce selective attention to symptoms, and results in anxiety and exacerbation of other affective symptoms. A parallel example is age, in which older adults selectively attend to failures in memory and attribute these to their age, based on their belief of poor memory in old age, regardless of any real changes in memory.

Self-efficacy about memory functioning refers to beliefs about one's ability to use memory effectively, and the degree to which one believes memory performance is under personal control (Kit, Mateer, & Graves, 2007). As noted above, expectations of the degree of impairment after TBI moderates the relationship between self-efficacy and health outcomes. One way in which this may occur is with the frequency and degree to which rehabilitative strategies and aids are used. For example, individuals with TBI who expect a large degree of cognitive impairment, and who have high levels of self-efficacy may use rehabilitation strategies and aids more than those with low levels of self-efficacy, or who underestimate their degree of impairment. The present research aimed to evaluate the impact of self-efficacy on the use of reminder scheduling software on a mobile phone to assist with EM.

An Operational Definition of Everyday Memory

The prospective component of EM involves three main characteristics. Firstly, there is a delay between the formation and execution of an intention, secondly there is limited or no vocal or sub-vocal intention rehearsal and it involves self-initiated retrieval and execution of the intention (Burgess et al., 2001). The amount of self-initiated retrieval varies according to the prospective task. Time-based prospective tasks rely more on self-initiated retrieval than event-based tasks, which are naturally supported by external cues. For example, remembering to take medication at a particular time without the use of an external reminder such as an alarm (time-based prospective task) requires more self-initiated retrieval than remembering to give a message to a particular person when that person is encountered (event-based prospective task). In the example of an event-based task, the person to which the message is to be delivered serves as a natural environmental cue (Schmidt et al., 2001).

Prospective memory is elicited when participants are given the task to remember an intention upon encountering a specific cue, and when, in the time interval between instructions and cue presentation, they stop thinking about the upcoming task. EM is successful when participants indicate at the appropriate time their awareness that they must perform the assigned task (prospective component), remembering what the task is (retrospective memory), and doing the task (task execution). A number of factors complicate translating EM into an operational definition. Firstly, it is difficult to operationalize the subjective state of not thinking about the action to be completed during the time interval. This component is what differentiates prospective memory from vigilance tasks (Ellis & Kvavilashvili, 2000).

The second difficulty in operationalizing EM pertains to the distinction between time-based cues and event-based cues (Einstein & McDaniel, 1990). Time-based cues are defined by the passage of time, whereas event-based cues are embedded in the situation and depend on the occurrence of an event. Einstein and McDaniel (1996) argue that external environmental support for the retrieval of information is provided in event cues, but not in time cues. According to the definition developed for this work, the critical feature of the EM cue is time. Since time cues lack environmental support, the mobile phone reminder scheduling software was selected in the present study to provide an attention-capturing property (alarm sound). Event-based cues have to be translated into time-based cues in order for the alarm to be programmed for the correct time. In the baseline condition the cues needed to be discovered, whereas in the treatment condition the time-based cues were provided.

For the purpose of the present research the subjective state of not thinking about the intended task was operationalized as engagement in activities other than the intended activity until the presentation of the cue, and the presence of a time lapse between the formation of the intention and the cue. The intended tasks were formed up to two-weeks in advance. Everyday memory was further operationalized as the frequency of accurately executing time-based tasks at the correct time, with and without the use of automatic reminders sent to participants' mobile phones. Metamemory was operationalized as insight into memory difficulties, and was measured as part of an overall indication of insight into a range of difficulties.

Summary

This chapter provided an overview of the theoretical divisions of memory, the stages of memory processing and the theoretical structure of EM. Prospective memory was defined as comprising a delay between the formation and execution of an intention, limited or no vocal or sub-vocal intention rehearsal and self-initiated retrieval and execution of the intension (Burgess et al., 2001). The distinction between event-based and time-based cues was discussed to illustrate the need to convert event-based cues to time-based ones when using EMAs. The definition of prospective memory was extended to operationalize

EM as the frequency of accurately executing time-based tasks at the correct time, with and without the use of automatic reminders sent to participants' mobile phones. The strategies employed in memory rehabilitation are discussed in the following chapter.

CHAPTER THREE: NEUROPSYCHOLOGICAL REHABILITAITON

Introduction

Cognitive rehabilitation aims to ameliorate the consequences of cognitive deficits facilitated by understanding and coming to terms with the deficits. Rehabilitation of cognitive deficits such as memory serves to enhance the quality of life for injured people and lessen the burden for their family members and support services (McCourt, 2002). The goal of increasing functional independence is at the core of cognitive rehabilitation. This is best achieved by means of a thorough assessment and a goal planning approach to rehabilitation, in which memory impaired clients, their families, and rehabilitation staff negotiate treatment goals and strategies (Wilson, 2002).

Approaches to memory rehabilitation include restoration or recovery of function, and compensation for deficits. The restoration approach is based on the assumption that damaged processes can be restored or improved upon, and that this will facilitate an overall reduction in memory impairment. The compensatory approach is based on the assumption that damaged memory processes cannot be recovered, and aims to bypass damaged processes. Restoration techniques involve teaching a lost skill, whereas compensation involves capitalizing on intact skills to teach the use of a tool to overcome lost abilities. For example, one approach in the restorative paradigm is massed practice, where an individual is required to repeatedly practice a task, such as memorizing a series of numbers (e.g. the Digit span subtest of the WAIS-III) with the aim of improving working memory deficits.

The compensatory approach has the largest evidence base, and will be emphasised both in this chapter and in this research study. However, a discussion of the restorative approach to memory rehabilitation is provided in order to provide a rationale for the approach chosen for the present research.

Restoration of Memory

A restorative approach to memory rehabilitation aims to restore some degree of memory skill, which in turn facilitates functional adaptation in everyday life.

However, retraining techniques to restore EM function have been largely unsuccessful (Fujii, 1996; Wade & Troy, 2001).

Training within the restorative paradigm is very laborious and offers little improvement in terms of generalizing the learnt skill into everyday life. Even though rehabilitation techniques such as rehearsal strategies, organizational techniques, and imagery mnemonics have support in individual cases, they lack empirical evidence for long-term positive outcomes (Fujii, 1996). The generalization of improvements that have resulted from cognitive retraining and mnemonic strategies is questionable. In a study investigating the efficacy of prospective memory training in older adults, Schmidt et al. (2001) reported small performance improvements on prospective memory measures. However, these improvements failed to generalize and were not maintained at six-month follow-up. Instead of such gains transferring to learning situations in everyday life, people with memory problems (in the absence of external cues and instructions) tend to revert back to using external memory aids (Richardson, 2000).

Within the compensation paradigm, memory deficits are viewed as irreparable beyond spontaneous recovery. The focus is on teaching people to use different tools and strategies to compensate for an underlying memory problems. For example, the use of pocket phone books or the "contacts" function on mobile phones can be used to record and later access phone numbers. Similarly, a "tag" or noting a salient feature of a person's face or name can be added to assist with remembering names and faces, rather than repeatedly practicing a face recognition task. The goal of memory compensation is outlined in the next section, following an overview of non-electronic and electronic compensatory strategies and aids.

Compensation for Memory Impairment

Internal strategies

Compensatory aids comprise internal aids (e.g., mnemonics, visual imagery, peg-word, association) or external aids, which are either electronic (e.g. pagers, mobile phones, personal digital assistants) or non-electronic (e.g. lists, diaries, wall charts). These can be adapted in accordance to individual strengths and goals to assist with cognitive compensation. Internal strategies are tasks that involve thinking, such as mnemonics, peg-word techniques and associations. The difficulty with using internal strategies with a memory-impaired population is that internal strategies rely on spontaneous cue recognition. The individual has to first remember to remember, remember to apply the internal strategy, and recognize when to remember. This may partly explain the limited efficacy of internal strategies, compared to external aids. (Fujii, 1996; Wade & Troy, 2001). These abilities form the basis of EM functioning, and are what is impaired following TBI.

External strategies

While there is more evidence to support the utility and effectiveness of external strategies after TBI, there are limitations. For example, post-it notes are less useful when they are used in a disorganized fashion. They serve as a cue only if they are in view of the individual, and are recognized as a cue to complete an intended task. Other external strategies, such as using the same daily or weekly routine rely on the formation of habits to orient the individual to naturally occurring cues. One difficulty with this approach is that novel tasks are not supported. The ideal external aid would provide a salient auditory or visual cue at the right time, the most relevant information to support the execution of an intended action, and feedback on task execution. Electronic external aids have the capability to fulfil at least some of these requirements. Mobile phones were selected for this study, as they are versatile and adaptable to the particular needs of the individual.

Training for the use of a compensatory strategy is guided by the specific goal of the rehabilitation. Simmons-Mackie and Damico (1997) formulated the operational definition of compensatory behaviour. The present research attempted to incorporate these characteristics in the design of the study. The characteristics of compensations include purposeful and goal-directed attempt to overcome a particular impairment, adaptation of pre-existing behaviour to assist with compensation of a function, the employment of strategies in a flexible fashion that reflect the particular context, individualized strategies, and employing strategies that are spontaneous rather than trained. Errorless learning is one technique used to assist those with TBI in acquiring new skills, such as learning to use a memory aid.

Errorless Learning involves preventing mistakes in learning during skill or information acquisition. In contrast to trial-and-error learning, errorless learning relies on the presentation of correct procedures and the minimization of erroneous responses. People with memory problems rely on non-declarative memory for learning and may lack the explicit memory capacity necessary to remember and eliminate previously learnt errors. Non-declarative memory is thought to support errorless learning. Various techniques, including physically prompting a particular response, providing written instructions, and providing the correct information immediately prior to a client responding, are used in errorless learning. Anecdotal evidence supports the efficacy of errorless learning with a range of memory disorders, including amnesic disorders and Alzheimer's disease (Clare, et al., 2002). A brief discussion on various external aids follows.

Environmental Aids

Adaptations to the immediate environment (ergonomics), such as the design of a room, are considered proximal environmental memory aids (Kapur et al., 2004). Few studies have investigated the use of ergonomics as EM prostheses. However, there is support for a well-structured and organized environment in which categories that are meaningful to the individual are used to aid with remembering (Kapur et al., 2004). For example, storing medication to be taken with breakfast next to the breakfast cereal will assist with remembering to take medication at the appropriate time.

Recent studies investigated the use of motion sensors, video cameras, and plan recognition software in assisting people with activities of daily living. For example, the Cognitive Orthosis for Assistive aCtivities in the Home (COACH) device is an interactive system that has successfully aided people with dementia to complete hand washing independently. The development of an instrumented environment, using an entire house as a memory orthotic is underway (Mynatt, Essa, & Rogers, 2000, cited in LoPresti et al., 2004). Changes to environments other than the person's home are considered distal environmental memory aids. For example, maps in shopping centres, traffic warning signs, and wall or floor markers in a hospital are all distal environmental memory aids that have the potential to enhance EM functioning (Kapur et al., 2004).

A more recent distal environmental device is MemoClip, which communicates via location beacons to determine the user's location. Text messaging is then used to provide this information to the user to assist with navigation, provide directions, and safeguard people prone to wandering, which are frequently seen in patients with dementia. MemoClip can also be viewed as a portable memory aid (Alm et al., 2004).

Portable External Memory Aids

Portable memory aids include non-electronic aids such as "Post-It" notes, diaries, calendars and wall charts, and electronic memory aids such as palmtop organizers, speech storage devices, pagers, and mobile phones (Kapur et al., 2004). The evidence for the effectiveness of non-electronic aids is limited. For example, nine weeks of notebook training with supportive therapy, aimed at reducing EM deficits in a group with severe brain injury, failed to maintain statistically significant treatment gains at six month follow-up (Schmitter-Edgecombe, Fahy, Whelan, & Long, 1995). Aids such as wall charts and notice boards, are not easily transported (Sohlberg & Mateer, 2001). Electronic aids have the potential to combine the functions of non-electronic aids and are more easily transportable.

Electronic Memory Aids

The efficacy of electronic aids, including reminder and communication devices, and organizers has a wide evidence base (Kapur et al., 2004). These devices are applied to assist with a range of difficulties including communication, sensory skills, language processing, learning and memory. Electronic systems have been successfully used to aid a group of people with dementia to increase their level of communication. This was achieved through the use of an interactive multimedia system during reminiscence therapy, which utilizes cognitive strengths such as preserved long-term memory (Alm et al., 2004).

One system that has received considerable research attention is NeuroPage®, a portable paging system that is used to transmit personalized messages at appropriate times in order to remind people with memory deficits to initiate a task. For example, messages may include reminders to attend appointments, take medication, or perform everyday tasks such as walking the dog. Although alphanumeric paging systems such as the NeuroPage® system have well demonstrated efficacy (Kirsch, Shenton, & Rowan, 2004; Wilson et al., 2001; Wilson et al., 1997), advances in technology and the introduction of mobile phones and smart devices drastically reduces rate of use and social acceptance of pager systems, particularly in the younger population. Furthermore, the use of pagers is limited to people with intact reading, visual and perceptual abilities (Wade & Troy, 2001). The limitations of NeuroPage® may be able to be overcome through the use of mobile phones, which have additional functions to those of the pager, including two-way voice communication, in many cases picture and video communication, and "live" mobile-internet that can be used creatively to compensate for memory and organizational deficits.

The only study investigating the utility, user friendliness, and effectiveness of mobile phones as an external memory aid (Wade & Troy, 2001) reported overall positive outcomes for the use of mobile phones as an external cueing system, with benefits pertaining to memory, and planning/organization. Technological advances in mobile communication such as picture- and video messaging were not available at the time that study was conducted.

The use of voice organizers and dictaphones to record reminders such as appointments or therapy goals is also supported by research evidence (Hart, Hawkey, & Whyte, 2002; Oriani et al. 2003; van den Broek, Downes, Johnson, Dayus, & Hilton, 2000). For example, voice organizers can be used to record shopping lists, and review when needed; or to record an interesting event that took place. A voice tag (i.e. "shopping list") is assigned to each recording for easy access at a later time. As well as improved performance in measures of

EM, these studies found that the use of voice organizers increases awareness and memory of therapy goals (Hart et al., 2002). Another potential area in which technology may contribute to rehabilitation is through the use of computer-based resources.

Computer-based resources can be used as instructional tools that teach memory strategies, domain-specific knowledge, and virtual-reality rehabilitation. Web-based assistive technology for cognition is an extension to already available devices such as palmtop computers, with the added benefits of being completely portable, accessible from any internet-enabled computer or mobile phone, and flexible enough to personalize according to individual needs (Kirsch, et al., 2004). The use of web-assisted technology is a promising prospect with anecdotal support for treatment efficacy and maintenance of treatment effects for both memory and strategizing skills (Kirsch, et al., 2004). The studies outlined above are summarized in Table 5.

Despite the large number of electronic memory aids available, there are limitations regarding their use with brain-injured populations. Often mentioned factors limiting the utility of electronic aids include the need for training in the use of the device (Kapur et al., 2004), limitations of use due to visual deficits, poor manual dexterity, or expressive speech impairment (van den Broek, Downes, Johnson, Dayus, & Hilton, 2000), lack of insight into the memory disorder (Kim, Burke, Dowds, & George, 1999), additional demands on rehabilitation teams such technical expertise to install and activate wireless module software on a portable device, and increased expense (Kirsch, Shenton, Spirl, et al., 2004).

Table 5
Efficacy studies of memory aids in cognitive rehabilitation

Source	Population	Groups	Procedure	Outcomes/ Analysis	Results
Hart, Hawkey, & Whyte 2002	Community program volunteers with mild to moderate TBI (N=10) Chronicity: 3months – 18 years	Treatment: Voice organizer training and trials Comparison: None	Intervention duration: 3x training sessions 1-week trial Follow-up: None	Subject's recall of 3 recorded & 3 unrecorded goals Friedman nonparametric repeated measures analysis	Recorded goals- 4.4 (SD-3.0) – free recall Unrecorded goals- 0.5 (SD-0.8) – free recall Recorded goals- 5.5 (SD-1.9) – cued recall Unrecorded goals- 2.1 (SD-1.6) – cued recall
Wright et al. 2001	Not stated TBI – memory impaired (N=12) Chronicity: 2-12 years (SD- 6 years)	Treatment: Comparison of two styles of pocket computers	Intervention duration: Use of one machine for 2 months, one month interval, use of second machine for 2 months Follow-up: None	Frequency of use – electronically recorded Ease of use Qualitative NART, RBMT, SCOLP, BADS and frequency of use – Pearson's r	No significant correlations between any of the psychometric measures and frequency of use
Kim et al. 1999	In-patient rehabilitation TBI (N=1) Chronicity: 2 months	Treatment: Use of micro computer Comparison: None	Intervention duration: Not stated Follow-up: None	Goal activities	Patient achieved all goals within days
Wilson et al. 2001	Referrals People with memory problems and executive deficits (N=143) Chronicity: SD-5.92 years	Treatment: NeuroPage efficacy study Comparison: None	Intervention duration: Randomized cross over study: 2 weeks baseline, group A 7 weeks + group B 7 weeks on waitlist: Group B 7 week tx + group A 7 weeks with no pager Follow-up: 7 weeks	Activities of everyday living- target behaviours Odds ratio test	Success % Group A B Base line: 46.82 48.63 7 weeks: 74.47 48.18 14 weeks: 62.15 76.13

Source	Population	Groups	Procedure	Outcomes/ Analysis	Results
Kim et al. 2000	Outpatient volunteers TBI (N=12) Chronicity: 4 - 135 months	Treatment: Use of micro computer Comparison: None	Intervention duration: Not stated Follow-up: 2 months- 4 years	Survey Qualitative	9 found computer useful 7 continued with its use
Kirsch et al. 2004	In-patient rehabilitation TBI (N=1) Chronicity: Not stated	Treatment: Use of alphanumeric paging system Comparison: None	Intervention duration: Number of weeks Follow-up: None	% of memory log entries	A: 22.38% B: 93.57% A: 49.22%
Oriani et al. 2003	Outpatient volunteers with Alzheimer's disease (N=5) Chronicity: Not stated	Treatment: Electronic memory (EMA) aid use Comparison: None	Intervention duration: 3 x 1 hour sessions: 1- free recall 2- recall with written list 3 – recall with EMA Follow-up: None	Memory of seven tasks ANOVA	Mean and SD: Free recall: 0.8; 1.79 List recall: 3.1; 6.93 EMA recall: 15.4; 6.66
Wade & Troy 2001	Outpatient volunteers TBI (N=1 per study x 5) Chronicity: Not stated	Treatment: Use of mobile phones Comparison: None	Intervention duration: 6 weeks baseline 12 weeks treatment Follow-up: None	Self-initiated target tasks	Case 1: 100% success Case 2: 100% success Case 3: 92% success Case 4: 100% success Case 5: 81% success
van den Broek et al. 2000	Outpatient volunteers (N=5) Chronicity: 19 – 54 months	Treatment: Use of voice organizer Comparison: None	Intervention duration: A: 3 weeks B: 3 weeks with organizer A: 3 weeks Follow-up: None	Message passing task with 9 hour delay Domestic task – household chores with 1-6 day delay	Message passing task A: mean 2.4; SD 3.6 B: 18.2 5.5 A: 5.0 5.8 Domestic task A: mean: 3.8; SD: 4.9 B: 10.0 2.1 A: 4.2 4.8

Hart, O'Neil-Pirozzi, and Morita (2003) investigated clinician expectations for the use of electronic cognitive/behavioural prostheses following brain injury. They found that clinicians view such devices to be the most beneficial in the areas of learning and memory, planning and organization, and initiation, with all of these areas being critical to independent functioning. However, the clinicians expressed concern about their ability to provide clients with the needed guidance in the use of such devices (Evans, Wilson, Needham, & Brentnall, 2003). Two studies (Evans et al., 2003; Wilson & Watson, 1996) investigated which memory aids are spontaneously used by people with memory difficulties, the perceived effectiveness of these aids, and the characteristics that predict the use of memory aids. Both these studies were limited to people who sustained traumatic brain injury.

Evans et al. (2003) found that in a group of 96 memory-impaired people with acquired brain injury all but two cases used compensatory strategies to help with remembering. They found that non-electronic external aids such as wall charts and calendars were the most commonly used aids, and that the combination of current age, time since injury, number of premorbidly used aids, and attentional functioning is most predictive of memory aids use. They also replicated the findings of Wilson and Watson (1996), finding a relationship between use of a greater number of memory aids (6 or more) and functional independence, that absence of marked cognitive deficits and memory impairment are related to the number of memory aids used, and that premorbid use of five or more aids is related to the number of aids used post-injury. An interesting finding was that a high level of distress as measured by the European Brain Injury Questionnaire (EBIQ) is related to a higher number of strategies used. Age is also related to recovery from brain injury (Asikainen, 2001), and the number of memory aids used (Evans et al., 2003).

Summary

Wilson (1991) emphasizes the importance of theory in neuropsychological assessment and rehabilitation. Theory driven advances in EM assessment and rehabilitation resulted in a proliferation of memory restoration techniques and compensatory strategies. However, an understanding of the factors that contribute to the effective use of rehabilitation strategies is still limited. Cognitive rehabilitation, and especially the development and use of electronic aids, is advancing rapidly. The availability of these systems is increasing and cost is decreasing. However, research evaluating the efficacy of electronic aids is relatively infrequently conducted. The technology also often outpaces the technological skills of care workers and the time it takes for studies of efficacy to appear in research literature. Furthermore, special consideration is warranted in identifying any barriers to the effective use of available memory aids, such as limited resources or lack of psychosocial support (Kirsch, Shenton, Spirl, et al., 2004). The present research aims to investigate the spontaneous use of these strategies in assisting with cognitive difficulties in Study One, as well as the efficacy of mobile phones as a cognitive aid in Study Two.

THE EXTENT AND NATURE OF ELECTRONIC MEMORY AID USE

CHAPTER FOUR: STUDY ONE

FORMULATION

Objectives

The main objective of this study was to investigate the nature and extent of the spontaneous use of cognitive aids by people with memory difficulties, and to compare this with that of the general population.

Aims

This study aimed to explore the relationships between the self-perceived use of memory aids, and age and insight into functional difficulties. It also aimed to explore if relationships exist between pre-injury use of memory aids and post-injury use of memory aids. Furthermore, it intended to compare brain-injured participants and control participants in their use of memory aids. The research questions were as follow:

Question 1: How much of the variance in the number of memory aids used by people with TBI can be explained by current age, sex, injury type, and time since injury? Which of these variables is a possible predictor of the number of aids used?

Question 2: Is there a relationship between the level insight into functional difficulties, as indicated on the Patient Competency Rating Scale, and the frequency of memory aids use?

Question 3: Are there any differences in the pre-injury use of memory aids versus the post-injury use of memory aids?

Question 4: Are there any differences between people with memory impairments and age-matched controls in the number of memory aids used, including overall use, use of EMAs and use of non-EMAs?

Question 5: Are non-electronic aids used more frequently than EMAs by both groups?

Question 6: Are electronic devices considered to be more effective than non-electronic devices?

Question 7: Are the most widely used aids considered to be the most effective as indicated on the Memory Aids Questionnaire (MAQ)?

Question 8a: Does the frequency of EMA use decrease with increasing age?

Question 8b: Does the frequency of the use of mobile phones as memory aids decrease with increasing age?

METHOD

Design

Study One of the present research was a pilot study designed to inform Study Two and to gather initial estimates of the extent to which people use memory aids, and particularly EMAs. It employed a survey design, which involved participants completing the Memory Aids Questionnaire ([MAQ], see Appendix 1), and the Patient Competency Rating Scale ([PCRS – Patient form], see Appendix 2). Caregivers, partners or friends of participants were asked to complete the memory aids checklist about their own use of strategies to help them remember, and to complete the PCRS – Relative form. They served as a control group and were age-matched to primary participants. The MAQ was a questionnaire created for the present research, and the PCRS was selected as it is a widely used measure in New Zealand.

The researcher is a clinical student in the Doctorate of Clinical Psychology programme at Massey University. Data was also collected by treating clinicians, i.e., clinical psychologists, at the Psychology Clinics, Massey University and at Cavit ABI.

Participants

Two groups of participants were recruited: a group of people with memory difficulties after TBI, and a control group. The TBI group was selected from memory-impaired people who attended Massey University Psychology Clinics in Wellington and Palmerston North, the outpatient clinic at Ranworth Healthcare in Hamilton, Brain Injury Association (BIA) or Head Injury Society meetings, and Cavit ABI rehabilitation in Auckland. Control participants were age-matched family members, friends or caregivers of the TBI participants.

The Psychology Clinics at Massey University are specialist clinical psychology service providers and clinical research centres, which have regular contact with people who sustained TBI. The goal of this research, which was to contribute knowledge with regard to effective rehabilitation interventions, was well matched with the work of the Psychology Clinics. Ranworth Healthcare and Cavit ABI are specialist residential assessment and rehabilitation service providers for people who have suffered traumatic brain injuries.

The Brain Injury Association of New Zealand (BIA) provides information, advocacy and support to people with brain injury and their families. The BIA has 13 affiliated regional associations, which includes the Head Injury Society, around New Zealand. The researcher contacted liaison officers in the Auckland, Bay of Plenty, and Waikato regions to arrange attendance at support group meetings. Two meetings were attended in Hamilton, two in Cambridge, two in Morrinsville, one in the Bay of Plenty, two in Auckland, and one in the North Shore.

Inclusion criteria were a history of traumatic brain injury, self-reported difficulties in everyday memory, and an age of at least 16 years.

Caregivers, relatives and friends of a similar age to primary participants were also invited to participate. They served as an age-matched control group to identify the strategies used by a healthy population, and to provide information regarding primary participants' level of insight.

Characteristics of participants

Of the 64 TBI people, and the 60 healthy people invited to participate in the study, 33 TBI and 29 healthy people participated. Data from 2 of the 64 were excluded because the questionnaires were only partly completed.

TBI Group Characteristics

The TBI group comprised 33 people. There were 20 males, and 13 females in the sample. Ages ranged from 16 years to 68 years (M = 44.88, SD 14.23). Causes of injury and memory difficulties included motor vehicle accidents, falls, assaults, sport related injuries, stroke, and other causes. Level of education was from "Some secondary school" to PhD or MD. Three participants owned pagers, 27 participants owned mobile phones, 22 owned personal computers and 20 had access to the internet.

Control Group Characteristics

The Control group comprised 29 people. There were 9 males, and 20 females in the sample. Ages ranged from 16 years to 68 years (M = 45.18, SD 14.26). Level of education ranged from "Some secondary school" to "Some postgraduate" (see Table 6). No participants owned pagers, 27 owned mobile phones, 26 owned personal computers and 28 had access to the internet. These characteristics are presented in Table 6.

Table 6
Summary statistics of sample characteristics.

	Total	TBI	Control
Condition	N 62	N 33	N 29
Gender			
Male	29	20	9
Female	33	13	20
Mean Age		44.88	45.52
Level of Education			
Some secondary school	25	16	9
NCEA 1; School Certificate	11	7	4
NCEA 2; University Entry	2	1	1
NCEA 3; Bursary	1	0	1
Trade; Certificate, Other training	14	5	9
University graduate	6	3	3
Some postgraduate study	2	0	2
PhD, MD	1	1	0
Cause of Injury			
Motor Vehicle Accident	15	15	0
Fall	4	4	0
Assault	1	1	0
Sport related accident	3	3	0
Stroke	2	2	0
Other	8	8	0
No injury	29	29	0
Pager Ownership			
Yes	3	3	0
No	59	30	29
Mobile phone Ownership			
Yes	54	27	27
No	8	6	2
Computer Ownership			
Yes	48	22	26
No	14	11	3
Internet access			
Yes	48	20	28
No	14	13	1

Measures

Memory Aids Questionnaire (MAQ)

The MAQ is a checklist of commonly used strategies/aids for assisting with memory, with respondents asked to rate the frequency of their use (never, rarely, sometimes, often), and their perceived efficacy (usually useful, sometimes useful, or rarely useful). Participants were asked to add to this list any strategies / aids that they use that were not already on the list. The MAQ is based on the strategies identified by the participants in the study conducted by Evans et al. (2003). Changes made to the questionnaire following the pilot study were in the wording, format and layout, and grouping similar aids together on the form. The questionnaire was then evaluated for ease of use, understanding, and appropriateness of use with people with TBI by two Clinical Psychologists working in the area of brain injury assessment and rehabilitation. Amendments were made to the questionnaire, which was then trialled by three clients with brain injury at The Psychology Clinic, Massey University in Wellington. The clients reported that they found the questionnaire easy to understand and comprehensive. The reliability and validity of the MAQ are not yet established.

Patient Competency Rating Scale (PCRS) –Patient & Relative forms

The PCRS is a 30-item self report instrument that measures a patient's perceived level of competency in a range of behavioural, emotional, and cognitive tasks. It also provides information on the patient's level of insight and awareness of brain injury related difficulties. Respondents are required to rate on a 5-point Likert scale the perceived difficulty or ease with which they (or the person with brain injury) complete a range of cognitive, emotional, interpersonal and activities of daily living (ADL) tasks. The PCRS possesses adequate reliability. Test-retest reliability was reported for 27 of 30 items in the patient sample, and for 28 of 30 items in the informants sample ($p < .05$). The PCRS was designed to measures perceptions of competency rather than actual competent behaviour. It was felt to be useful in getting an estimate of the TBI participants perceived level of insight. The measure is completed from the patient perspective regarding their own competency, and from a relative's perspective regarding the patient's level of competency.

Procedure

Members of the BIA were provided information about the study at one of their support group meetings by the principal investigator and invited to complete the two questionnaires. At the Psychology Clinics the treating Clinical Psychologist explained the study, invited people to participate, and collected the outcome data. Participants at Ranworth Healthcare were informed about the study by their treating clinician. Formal invitation to participate was then made by the researcher, and data collection carried out by the researcher after any formal assessment being conducted by the service themselves had been completed. Participants at Cavit ABI were invited to take part by their treating clinician, who also carried out the data collection. Participants had the option to take the questionnaires home to complete at a later time and return by post.

Caregivers, relatives or friends of participants who accompanied participants to the clinics/meetings were invited to complete the Memory Aids Questionnaire regarding their own use of memory aids and these participants served as age-matched controls. Caregivers were also asked to complete the Patient Competency Rating Scale- Relative form (Appendix 3), about their relative with TBI.

RESULTS

Question 1: How much of the variance in the number of memory aids used by people with TBI can be explained by current age, sex, injury type, and time since injury? Which of these variables is a possible predictor of the number of aids used?

In the current sample, only age appeared to be related to the number of aids used. Standard multiple regression analysis was performed in order to ascertain how much of the variance in memory aid use can be explained by the following set of variables: current age, sex, injury type, and time since injury. Only current age was correlated to the number of aids used (Pearsons r = .49). This model explains 19.1% (Adjusted R square) of the variance in the number of aids used, [F (2, 175) = 4.31, p = .02]. Of these variables, age makes a contribution (beta = .48). The other variables (sex, injury type, and time since injury) may also contribute to the variance.

Question 2: Is there a relationship between the level insight into functional difficulties, as indicated on the Patient Competency Rating Scale, and the frequency of memory aids used?

In the present sample, those with a high level of insight tended to use a similar amount of aids (M = 14.55, SD = 3.93) as those with a low level insight (M = 13, SD = 6.2).

Question 3: Are there any differences in the pre-injury use of memory aids versus the post-injury use of memory aids?

The pre- and post-injury frequency of use for each aid or strategy was calculated. The one person who used a pager previously no longer did so after their injury. The use of Pocket phonebooks, Mnemonics, Peg-word associations, Limiting tasks, Time of day, and Rhymes remained the same.

All 32 remaining strategies increased in frequency of use from pre-injury to post-injury with the largest increases observed in: the use of a Pillbox (n=1 to n=11); Instructions for use (n=1 to n=10); Mobile phone – alarm (n=2 to n=9); Placing medication in a special place (n=7 to n=23); Notes in special places (n=7 to n=21); and a Mobile phone – calendar (n=3 to n=9).

Rhymes, Mobile phone video messages, and mobile phone e-mail were never used by the TBI group. The most frequently used strategies were: Lists (n=17 to n=30); Asking others for reminders (n=16 to n=29); Mental retracing (n=18 to n=27); Repetitive practice (n=15 to n=26); Wall charts (n=13 to n=26); and a Daily Routine (n=18 to n=25).

Question 4: Are there any differences between people with memory impairments and age-matched controls in the number of memory aids used, including overall use, use of EMAs and use of non-EMAs?

The number of aids (overall, electronic, and non-electronic) used by the group with memory impairment was compared with the number of aids used by the age-matched controls. Table 7 contains data on the number of participants using a particular memory aid.

Overall: Those with a memory impairment (M = 15.03, SD = 5.13) and age-matched controls (M = 14.79, SD = 7.1) tended to be similar in their overall use of memory aids.

EMAs: Those with memory impairment (M = 2.09, SD = 2.19) and age-matched controls (M = 2.38, SD = 2.6) tended to be similar in their use of EMAs.

Non-EMAs: Those with a memory impairment (M = 12.52, SD = 4.22) and age-matched controls (M = 12.41, SD = 5.01) tended to be similar in their overall use of non-EMAs.

Table 7
The number of participants using a particular memory aid and mean efficacy ratings.

Remembering Strategy	…entage) of sam	TBI	
Visual Imagery	30 (48)	15 (45)	15 (52)
First Letter Mnemonics	14 (23)	8 (24)	6 (21)
Peg Word mnemonics	11 (17)	8 (24)	3 (10)
Chunk Information together	38 (61)	20 (61)	18 (61)
Home Computer	0 (0)	0 (0)	0 (0)
Electronic Organizer	0 (0)	0 (0)	0 (0)
Dictaphone or Voice Recorder	0 (0)	0 (0)	0 (0)
Pager	1 (2)	0 (0)	1 (3)
Mobile Phone- voice calls	25 (40)	13 (39)	12 (41)
Mobile Phone-voice messages	10 (16)	4 (12)	6 (21)
Mobile Phone- text messages	29 (46)	16 (17)	13 (45)
Mobile Phone- picture messages	6 (10)	0 (0)	6 (21)
Mobile Phone-video messages	3 (5)	0 (0)	3 (10)
Mobile Phone-e-mail messages	2 (3)	0 (0)	2 (7)
Mobile Phone-alarm function	18 (29)	9 (27)	9 (29)
Mobile Phone-calendar function	20 (32)	9 (27)	11 (38)
Daily Routine	43 (69)	25 (76)	18 (62)
Weekly Routine	39 (53)	23 (70)	16 (55)
Notes on a Wall Chart	49 (79)	26 (79)	23 (79)
Lists	57 (92)	30 (91)	27 (93)
Instructions for Activities	21 (34)	10 (30)	11 (38)
Appointment Diary	45 (73)	23 (70)	22 (76)
Pocket Phone book	19 (31)	7 (21)	12 (41)
Organizer handbag or Briefcase	32 (52)	13 (39)	19 (65)
Home Filing	38 (61)	19 (58)	19 (65)
Ask others to remind me	50 (81)	29 (88)	21 (72)
Place Objects in Unusual Places	36 (58)	22 (66)	14 (48)
Orientation of Medication	34 (52)	23 (70)	11 (38)
Notes in Special Places	30 (48)	11 (34)	9 (29)
Alarm Clock	19 (31)	8 (24)	11 (38)
Information on a key ring	7 (11)	4 (12)	3 (10)
Pillbox or Blister pack	12 (20)	11 (34)	1 (3)
Mental Retracing	54 (87)	27 (82)	27 (93)
Repetitive Practice	47 (76)	26 (79)	21 (72)
Associations	39 (53)	20 (61)	19 (65)
Alphabet Searching	24 (38)	12 (36)	12 (41)

Question 5: Are non-electronic aids used more frequently than EMAs by both groups, as indicated on the MAQ?

Both groups used non-EMAs more frequently (TBI group: M = 12.51; Control group: M = 12.41) than EMAs (TBI group: M = 2.09; Control group: M = 2.38).

Question 6: Are electronic devices considered to be more effective than non-electronic devices as indicated on the MAQ?

An independent samples t-test was performed on the mean efficacy ratings of the non-EMAs versus those for the EMAs. There was a statistically significant difference in efficacy ratings for EMAs (M =5.5, SD = .34), and non-EMAs [M = 4.69, SD = .49; t(30) = 5.09, p = .001] with EMAs rated more highly. The magnitude of the difference was moderate[1] (eta squared = .08), indicating that EMAs were considered more effective than non-EMAs by this sample.

Question 7: Are the most widely used aids considered to be the most effective as indicated on the MAQ?

In the present sample, non-EMAs were used more frequently (TBI group: M = 12.51; Control group: M = 12.41) than EMAs (TBI group: M = 2.09; Control group: M = 2.38), but EMAs were considered more efficacious [EMAs (M =5.5, SD = .34), than non-EMAs (M = 4.69, SD = .49)].

[1] .01 = Small effect; .06 = Moderate effect; .14 = Large effect (Pallant, 2001).

Question 8a: Does the frequency of EMA use decrease with increasing age?

One-way between group analysis of variance was applied to explore the impact of age on the use of EMAs. In order to test this hypothesis, participants were grouped according to their age (Group 1: under 40 years, Group 2: 41 to 53, and Group 3: 54+). The groups comprised equal numbers of participants. There was a statistically significant difference at the $p<.05$ level in frequency of EMA use for the three age groups [$F(2, 59) = 4$, $p = .02$]. The effect size, calculated using eta squared, was moderate (eta squared = .12).

Post-hoc comparisons using the Tukey HSD test indicated that the mean score for Group 1 ($M = 3.18$, $SD = 2.46$) was significantly different (i.e., used EMAs more frequently) from Group 3 ($M = 1.16$, $SD = 2.04$). That is, younger participants used EMAs more frequently than older participants. Those in the 41 to 53 years age group ($M = 2.19$, $SD = 2.23$) did not appear to differ from either younger or older people in the frequency of EMA use. However, there may be differences among these age groups in the wider population.

Question 8b: Does the frequency of the use of mobile phones as memory aids decrease with increasing age?

One-way between group analysis of variance was repeated to explore the impact of age on the use of Mobile phone voice calls, voice messages, text messages, picture messages, video messages, e-mail messages, mobile phone alarm, and mobile phone calendar. In order to test this hypothesis, participants were grouped according to their age (Group 1: under 40 years, Group 2: 41 to 53, and Group 3: 54+).

There was a statistically significant difference at the $p<.05$ level in frequency of mobile phone text message use for the three age groups [$F(2, 59) = 4.58$, $p = .014$]. The effect size, calculated using eta squared, was moderate (eta squared = .13). Post-hoc comparisons using the Tukey HSD test indicated that the mean score for Group 1 (M = 2.64, SD = 1.36) was significantly different from Group 3 (M = 1.42, SD = 0.90). That is, younger participants used mobile phone text messages more frequently than older participants. Those in the 41 to 53 years age group (M = 2.24, SD = 1.51) did not appear to differ from either younger or older people in the frequency of mobile phone text message use. However, there may be differences among these age groups in the wider population.

The difference between the groups were also significant at the $p<.05$ level for mobile phone – alarm use [$F(2, 59) = 5.16$, $p = .01$]. The effect size, calculated using eta squared, was large (eta squared = .15). Post-hoc comparisons using the Tukey HSD test indicated that the mean score for Group 1 (M = 2.55, SD = 1.71) was significantly different from Group 3 (M = 1.21, SD = 0.54). That is, younger participants used the alarm function on mobile phones more frequently than older participants. Those in the 41 to 53 years age group (M = 1.67, SD = 1.41) did not appear to differ from either younger or older people in this sample in the frequency of mobile phone alarm use.

The impact of age on the use of mobile phone – calendar function was significant at the $p<.05$ level for the 3 groups [$F(2, 59) = 4.21$, $p = .01$]. The effect size, calculated using eta squared, was moderate (eta squared = .13). Post-hoc comparisons using the Tukey HSD test indicated that the mean score for Group 1 (M = 2.41, SD = 1.53) was significantly different from Group 3 (M = 1.21, SD = 0.71). That is, younger participants used mobile phone text messages more frequently than older participants. Those in the 41 to 53 years age group (M = 1.95, SD = 1.49) did not appear to differ from either younger or older people in the frequency of mobile phone text message use.

DISCUSSION

This study aimed to investigate the nature and extent of the spontaneous use of cognitive aids by people with memory difficulties, and to compare this with that of age-matched controls. Specifically it aimed to explore the relationships among the self-perceived use of memory aids and strategies, and age and insight into functional difficulties; any differences between pre-injury use of memory aids and post-injury use of memory aids; and any differences and similarities between the brain-injured participants and age-matched controls in their use of memory aids.

The TBI group and the age-matched control group used a similar number of memory aids, and similar types of aids (EMAs and non-EMAs). A possible explanation for this finding is that the caregivers served as the control group. They often live in the same home, and caregivers are frequently responsible for assisting with reminding their family members of tasks. It is plausible that many of the strategies used by caregivers are the same as those for people with memory aids as they may choose to use similar aids as their family member to assist in their cognitive and emotional recovery. The caregivers may also use more strategies than the general population as they have additional demands on their own cognitive resources.

Two studies (Evans et al., 2003; Wilson & Watson, 1996) investigated which memory aids are spontaneously used by people with memory difficulties, the perceived effectiveness of these aids, and the characteristics that predict the use of memory aids. Neither study included a control group to evaluate difference between the TBI and general population in memory aids use. These studies found that the majority of memory-impaired people with acquired brain injury use mostly non-electronic compensatory strategies to help with remembering. Likewise, EMAs are widely available in New Zealand, but were not widely used by the participants in this study.

Although the variance in the number of aids used by the sample is partly explained by age, the sample was skewed with more participants in the 40 to 60+ age group. Older adults selectively attend to failures in memory and attribute these to their age, based on their belief of poor memory in old age, and regardless of any real changes in memory (Kit, Mateer, & Graves, 2007). This may result in older adults relying on a range of aids to assist with memory more often than when younger.

The present study used an opportunity sample, drawing mostly from people who attend support groups, which may suggest a higher level of insight into their difficulties than those who do not attend support groups. This in turn may impact on the number of strategies applied to assist with remembering.

Earlier research found a relationship between the number of memory aids used and functional independence, with six or more aids used being related to higher levels of functional independence (Evans et al., 2003; Wilson & Watson, 1996). Most of the participants in this study lived independently with some support from caregivers; all participants used more than six aids (range = 7.69 to 21.89).

Both groups used non-EMAs more frequently than EMAs. Although it is likely that sampling bias contributed to this finding, it is not unexpected. This finding is consistent with earlier research (Evans et al., 2003) that found that non-electronic external aids such as wall charts and calendars were the most commonly used aids.

Of the 38 strategies used by the participants, one declined from pre- to post-injury use, six remained the same, and for 32 the use increased. The increases in the use of pillboxes and orientation of medication are likely due to the increased demand for medication following the injury. People with TBI tend to overestimate their level of adaptive functioning before their injury, remembering with rose coloured glasses (Leathem, Murphy, & Flett, 1998). Participants with TBI in the present study may have underestimated their need for pre-injury use of memory aids.

The use of a pager decreased from pre-injury to post-injury, whereas newer technology such as mobile phone video messages, and mobile phone e-mail were never used by the TBI group. This may reflect the availability of different types of technology, and the need for rehabilitation professionals to stay 'up-to-date' with what is available to their clients and how to use these newer technologies creatively.

The most frequently used strategies also showed large increases in use from pre- to post-injury. This finding may indicate that the age-matched controls closer resembled the TBI group than the wider population in their use of memory aids. This can be explained by various factors including sampling bias, caregivers and those with brain injury sharing the same environment, caregivers using the same aids, and increased demand on the cognitive resources of caregivers necessitating the use of a larger number of aids. Furthermore, the participants all had self-perceived memory difficulties, which may have impacted on their view of the number of aids used pre-injury. Many stated that they did not need aids pre-injury, because they did not have memory difficulties.

The present study found a statistically significant difference in perceived efficacy between electronic and non-electronic memory aids, with a moderate effect size. EMAs were considered more effective with remembering than non-EMAs by those who use them. However, EMAs were used less frequently than non-EMAs. This finding is consistent with earlier research (Evans et al., 2003) that found that non-electronic external aids such as wall charts and calendars were the most commonly used aids.

As outlined in chapter three, various factors limits the utility of EMAs, including the need for training in the use of the device (Kapur et al., 2004), limitations of use due to visual deficits, poor manual dexterity, or expressive speech impairment (van den Broek et al., 2000), lack of insight into the memory disorder (Kim et al., 1999), additional demand on rehabilitation teams such technical expertise to install and activate wireless module software on a portable device, and increased expense (Kirsch et al., 2004). Furthermore, spontaneous reports from participants and rehabilitation professionals involved in this study suggested that EMAs continue to be used infrequently in rehabilitation.

In the present study, the younger participants (under 40 years) used more EMAs than the older group (over 54 years). This finding is similar to those of earlier studies, which found that age is related to recovery from brain injury (Asikainen, 2001), and the number of memory aids used (Evans et al., 2003), with the best recovery and the optimal memory aid usage found in the 17 to 40 years age group. This confirms that age also impacts on the type of aids used. This finding has important treatment implications as TBI occurs most frequently in the younger population (15 to 24 years), regardless of the cause of injury (Asikainen, 2001). Mobile phones are used prolifically by the younger population, which make them particularly promising as a cognitive rehabilitation device.

Evans et al. (2003) found that a high level of distress as measured by the European Brain Injury Questionnaire (EBIQ) related to the use of a larger number of strategies. This finding was not replicated in the present study. However, in the current study data on the level of insight was available for a few participants only (n=14). Sample bias can also explain the lack of a significant relationship between level of insight and the number of aids used. The majority of participants attended support meetings, which may be indicative of a higher level of insight and need for support and assistance. All participants used more than seven aids. Furthermore, response bias may have confounded the results, with participants under-reporting their difficulties and over-reporting the number of aids used.

Evans et al. (2003) found that the combination of current age, time since injury, number of premorbidly used aids, and attentional functioning is most predictive of memory aids use. The contribution of the number of premorbid used aids and attentional functioning were not investigated in the present study. The present study investigated the impact of current age, sex, injury type, and time since injury on the number of aids used. Only current age made a unique contribution. Time since injury did not appear to be related to the number of aids used by people with TBI, thus not replicating the finding by Evans et al. (2003). However, this is likely to be due to the impact of the small sample size.

The present study found that EMAs and in particular mobile phone text messages, mobile phone voice calls, and mobile phone calendar function, are considered to be more effective than non-EMAs, lending additional support to their use as cognitive aids. Rehabilitation efforts, particularly in the younger population, need to incorporate the use of EMAs already familiar to clients.

CHARACTERISTICS ASSOCIATED WITH SUCCESSFUL ELECTRONIC MEMORY AID USE

CHAPTER FIVE: STUDY TWO

FORMULATION

Objectives

The objective of the study was to investigate the usefulness of mobile phones in improving the functional independence of people who have sustained memory deficits following traumatic brain injury. Furthermore, the research investigated the impact of the type of memory impairment (encoding vs. retrieval), level of insight, and familiarity with technology on the use of mobile phones as cognitive aids. This part of the research utilized a repeated ABAB-single case design, evaluating the efficacy of using mobile phones in reducing everyday memory deficits. The single case experiments facilitate an in-depth study focusing on how the system can be improved and extended, as well as further investigating the characteristics that are related to the successful use of a mobile phone to assist with EM functioning.

Hypotheses

Question 1: Does the use of a reminder scheduling programme on a mobile phone improve everyday memory functioning?

Question 2: Does the efficacy of a reminder scheduling programme on a mobile phone improve as a function of pre-injury familiarity with mobile phones?

Question 3: Does the efficacy of a reminder scheduling programme on a mobile phone improve as a function of self-efficacy as measured on the Shapiro Control Inventory?

Question 4: Does the efficacy of a reminder scheduling programme on a mobile phone improve as a function of insight into difficulties as measured on the Patient Competency Rating Scale?

Question 5: Do participants who have predominant encoding difficulties show greater improvements in everyday memory functioning whilst using a reminder scheduling programme on a mobile phone, than participants who have predominant retrieval difficulties?

METHOD

Design

This study employed an ABAB single case experimental design. ABAB single case designs involve measuring behaviour during a baseline-phase (A), when introducing a treatment (mobile phone-reminder system)(B), after removing the treatment (A), and when re-introducing the treatment on an ongoing basis (B). Treatment was re-introduced to prevent the removal of potentially beneficial treatment. A one-month follow-up period was included in the design. Single-case experiments allow for a rich set of data that is difficult to achieve with large-sample designs due to financial and time constraints, it is the most efficient and reasonable approach to show that a new approach to treatment may have value, and with the recent focus in rehabilitation on individualized treatments it prevents treatment outcomes being misrepresented by group averages (Sarafino, 2005).

Participants

Six participants were selected from memory-impaired people who were claimants of the Accident Compensation Corporation (ACC) following acquired brain injury[2]. Two of the participants attended Massey University Psychology Clinic in Wellington for neuropsychological assessment and were invited to participate, and four were

[2] A further participant withdrew from the study following baseline data collection. She had severe insight difficulties. Her profile is provided in appendix 12.

referred to the study by their occupational therapist, in partnership with ACC. Inclusion criteria were a history of moderate (LOC: more than 20 minutes to 6 hours; PTA: 1-24 hours) to severe (LOC: more than 6 hours, PTA: over 24 hours) traumatic brain injury, self-reported difficulties in everyday memory, observed memory deficits as measured in a formal neuropsychological assessment, and being at least 16 years of age.

Cognitive and Injury-related characteristics

Participants ranged in age from 19 to 44 years. Injury severity included two moderate, and four severe cases of TBI. Months since injury ranged from 10 to 72 months. Causes of injury included two motor vehicle (deceleration) accidents, two pedestrian-vehicle (acceleration) accidents, a sports-related accident, and one hypoxic-anoxic accident. Diagnoses ranged from severe frontal-parietal injuries to hypoxic events. Five participants were familiar with the use of mobile phones before they sustained their injuries, five self-initiated their use post-injury, and one had never used a mobile phone. Participant characteristics are summarized in Table 8.

Cognitive characteristics of participants

A participant-by-participant summary of neuropsychological functioning is presented in Table 9. All six participants displayed a premorbid level of general cognitive functioning that was in the low average to average range. All exhibited across the board declines from pre-injury levels of functioning with some individual variance in specific domains. Whilst selective, focussed and alternating attention declined for all participants, three showed significant reductions in divided attention and one showed average ability. All displayed significant impairment in visual or verbal memory, and three had compromised working memory function. Information processing speed and Verbal Memory were the most affected modalities for most participants. Declines in executive functioning were also observed.

Table 8
Summary of demographic and injury-related data

Participant	Age	Sex	Injury severity	Months since injury	Pre-morbid use of technology	Post TBI Aids used
P1	44	M	Moderate	12	Mobile phone Home computer	Wall chart Mobile phone
P2	22	M	Severe	72	Nil	Mobile phone Verbal reminders
P3	25	M	Severe	10	Mobile phone	Verbal and written reminders
P4	42	M	Moderate	12	Mobile phone	Diary Others Notes on hand
P5	26	F	Severe	25	Mobile phone	Diary Wall chart Notice board
P6	40	M	Severe	24	Mobile phone Home computer	Others Routine Event-based reminders

Demographic information, injury-related information, and neuropsychological test information, were collected as part of a neuropsychological assessment conducted by the treating clinician, who selected the particular tests used for each participant. Neuropsychological tests used to assess the cognitive and emotional functioning of the participants were as follows[3]:

1. Pre-morbid and Current Intellectual functioning: *Wechsler Adult Intelligence Scale-III (WAIS-III).*
2. Attention: *The Wechsler Adult Intelligence Scale-III (WAIS-III) – digits forwards and backwards and the Delis-Kaplan Executive Functioning System* (D-KEFS) – the Trail Making Test
3. Memory and Learning: *The Wechsler Memory Scale-III (WMS-III); Auditory Verbal Leaning Test (AVLT); Rey-Osterrith Complex Figure Test (CFT).*

[3] The tests outlined were selected by the participant's treating clinicians. The tests used for each domain is attached in Appendix 13.

4. Information processing: *The STROOP word-colour interference test.*
5. Language: WAIS-III
6. Visio-spatial and Construction abilities – WAIS-III- block design; CFT –copy
7. Executive functioning: D-KEFS – Twenty Questions and Sorting task; WAIS-III- Similarities and Picture Arrangement; BADS Zoo map
8. Subjective distress/Insight: *Patients Competency Rating Scale (PCRS).*

Measures

Measures used in this study were the Patient Competency Rating Scale (PCRS), the Shapiro Control Inventory (SCI) and the Memory Aids Questionnaire (MAQ).

Patient Competency Rating Scale (PCRS)

The PCRS was used in Study One of the present research, and is described on page 49. Possible total scores on the PCRS range from 30-150, with higher scores indicating higher levels of competence. Discrepancies between caregiver or clinician scores and self-ratings indicate level of self awareness. Discrepancy scores are calculated by subtracting the total caregiver or clinician ratings from the self patient ratings, or by tallying the number of items rated as more competent, the same, and less competent by the patient as compared to the informant. Poor level of insight is indicated by high patient self-ratings as compared to low caregiver ratings (Leathem, Murphy, & Flett, 1998; Sherer, Hart, & Nick, 2002). Level of insight or self-awareness, measured by the PCRS, was operationally defined as the difference between the average perceived scores across all 30 items for patient and caregiver ratings. Poor insight was defined as an average difference of more than 20%.

Shapiro Control Inventory (SCI)

Self-efficacy was measured by the Shapiro Control Inventory (SCI), which is an 187-item self-report assessment tool designed to measure a person's current sense of control in the general and specific domains; mode of control status (cognitive and behavioural styles of responding to control-related issues);

Table 9
Participant by participant summary of neuropsychological functioning[4]

Domain	P1	P2	P3	P4	P5	P6
Premorbid Ability	Average	Average	Low Average	Average	Average	Low Average
Sustained attention	Low Average	Average	Low Average	Average	Low Average	Average
Selective attention	Impaired	Low Average	Impaired	Average	Very Impaired	Very Impaired
Focussed attention	Impaired	Average	Impaired	Average	Very Impaired	Impaired
Alternating attention	Impaired	Average	Impaired	Average	Very Impaired	Very Impaired
Divided attention	Impaired	Average	Impaired	Average	Very Impaired	Very Impaired
Visual memory	Impaired	Average	Impaired	Average	Impaired	Impaired
Verbal memory	Impaired	Very Impaired	Impaired	Very Impaired	Very Impaired	Very Impaired
Working memory	Impaired	Average	Impaired	Average	Very Impaired	Impaired
Information processing speed	Impaired	Very Impaired	Impaired	Impaired	Very Impaired	Very Impaired
Verbal reasoning	Average	Low Average	Impaired	Average	Average	Low Average
Visual reasoning	Average	Low Average	Impaired	Average	Average	Low Average
Visuospatial Ability	Average	Average	Average	Very Impaired	Average	Very Impaired
Executive functioning	Average	Low Average	Impaired	Average	Low Average	Impaired

motivation for control (including a desire for control, over-control issues and preferences for ways to deal with concerns); and the specific agency or sources of a sense of control (self, others, environment).This instrument is useful in identifying the source of positive outlook influencing disease state (self or others). Internal

[4] Very Impaired = 0.1st – 2nd percentiles; Impaired = 3rd – 8th percentiles; Low Average = 9th – 24th percentiles; Average = 25th – 73rd percentiles.

consistency (alpha = .70 - .89) and test-retest reliability (r = .67-.93) for this tool have been demonstrated. The strongest validity support is in the SCI's capacity to discriminate between normal and clinical groups. The SCI provides for assessment of the construct of control previously unmeasured by popular tools such as Rotter's LOC or Wallston's inventory (Shapiro, 1992). Only self-efficacy as measured by the SCI is reported for each participant.[5] Self efficacy was operationally defined as an average, above average or below average score on the Positive Sense of Control (Self-efficacy) score on the SCI.

The development of the MAQ involved compiling a list of strategies commonly used to assist with remembering based on the strategies identified by the participants in the study conducted by Evans and Wilson et al. (2003). This checklist of commonly used strategies/aids was revised and extended in order to identify those strategies used by the participant in the present study, the pre- and post-injury frequency of their use (never, rarely, sometimes, often), and their perceived efficacy (usually useful, sometimes useful, or rarely useful). None of the participants in Study Two had completed the measure before as part of Study One.

Equipment

Technological and Practical Considerations

The model of mobile phone selected for this study was guided by theory, technological requirements, available funding, and time-constraints. Study two in the present research aimed to use a compensatory strategy that built upon existing strategies spontaneously used by participants, as well as their premorbid skills that could be tailored to individual needs and contexts, and providing systematic and direct training in a naturalistic environment. Mobile phones were selected as the aid of choice as they possess ecological validity and can be utilized in accordance with Ellis's (1996) model of prospective memory: i.e.:

[5] The construct of control is complex. An explanation of the other aspects of control, and analyses of these aspects for each participant is provided in Appendix 11.

- Encoding: researcher, care-giver or self programming of device/entering or selecting tasks.
- Delay: a memory base on the phone that stores and manages reminders as well as transmission times.
- Performance interval: the phone rings and displays the message.
- Execution: messages can be of sufficient length to guide participants through necessary steps to complete a task.
- Evaluation: execution can be confirmed by means of self-monitoring by selecting the snooze function on the phone if the task has not been completed or selecting "stop" on the phone once the task has been executed (Thöne-Otto & Walther, 2003).

The overarching goal was to identify a phone, and select software, that was affordable, accessible and easy to use. An operating system is a platform that allows the software on the phones to operate. Operating systems on phones are similar to operating systems on personal computers, such as Windows XP. Advanced operating systems on mobile phones extend the functionality of the phones. For example, a range of software for particular needs can be added to the software already on the phone. These devices are called Smartphones. Three major operating systems were available on mobile phones at the outset of the present study. These were a Microsoft Windows-based system, a Symbian system, and a Palm system. Most brands of mobile phones at the time ran on one of these operating systems. Windows supported phones include "Windows Mobile" (I-mate and I-Jam) mobile phones, Palm supported devices include PalmPilots, and Symbian supported phones include Nokia, Panasonic, and Siemens phones. The BlackBerry Smartphone is a sophisticated digital device with extensive futures, and was considered for the present research. BlackBerry has its own operating system, which was written by RIM. At the time of the present study, the cost of BlackBerry devices excluded them from the study. I-Phone from Apple was released in New Zealand after the conclusion of the present study, but presents an alternative to the Nokia Smartphones used in the study, with I-Phones retailing for less, and offering more functions than the Nokia Smartphones.

Operating systems have different versions, each with different capabilities. For example, software can be written for or downloaded and installed on Symbian 60 supported mobile phones, but not on Symbian 40 supported phones. Similarly, Symbian 60 supported phones can be synchronized with software on a personal computer, such as Microsoft Outlook, whereas this is not possible with Symbian 40 phones. A Nokia 5500 Sport is an entry-level Symbian 60 smartphone, and was selected because of the possibility to add software that can aid with prospective memory difficulties. Windows mobile phones, PalmPilots, and BlackBerry devices all have the same capability, but their cost exceeded available funds for the study, and may exceed the financial resources of many people with brain injury.

Software Selection

The original conception for the study was to develop software particular to the needs of this population and based on the theory outlined above (Ellis's (1996) model of prospective memory). Consultation with software developers and mobile phone specialists commenced and the requirements of the software were outlined. The time needed for and the cost of software development exceeded the resources available for this study. Further more, no software developer who could write for Symbian operating systems was available in New Zealand or Australia. A decision to buy existing generic software was made and a search of available software commenced. This involved a further period of consultation with one software developer, and a search of Symbian compatible software on the internet. "Papyrus", developed by SBSH Software Development in Israel, was selected and installed on the mobile phones. Papyrus is organization and calendar software that is inexpensive, easy to use, and has undergone extensive testing. SBSH Software Development kindly donated the software to use for research purposes in this study.

Procedure

Referral procedures

Participants were referred to the study by professionals involved in their care (Occupational Therapist; Speech and Language Therapist), their ACC case-manager, or their treating Clinical Psychologist.

Assessment of Suitability

An initial interview to assess suitability for participation was conducted by the principal researcher in four cases. The interview involved gathering information regarding the nature and cause of the injury, their residual cognitive difficulties, level of insight into their difficulties, the memory compensatory strategies currently used, their status as ACC claimants, and access to neuropsychological reports, then a formal invitation to participate in the study was extended. For the remaining two cases, the treating clinician, who is a Clinical Psychologist, determined them suitable and invited them to participate in the present research. The study was explained to potential participants, and consent gained for participation, gaining access to information, and informing ACC case managers of their participation. A recent neuropsychological report was obtained by the researcher for each participant. A research assistant, who was a postgraduate student in the Clinical Psychology Training Programme at Massey University, Wellington, conducted training in the use of the phone and collected all data for one case study (P6).

Psychometric testing

The SCI was administered to obtain a measure of self-efficacy, the PCRS to obtain a measure of the level of insight that each participant has into their difficulties and the MAQ to record the strategies that they spontaneously used to assist with remembering before and after their injury.

Task Identification

Familiarity with technology was defined as ownership and use of a particular tool, such as mobile phones. Participants did not have to use the device to assist with remembering in order to be considered familiar with a device. A list of tasks and reminders was compiled for each participant. These tasks served as outcome measures. The number of tasks to remember varied across the different phases, which impacted on outcomes. The more tasks scheduled, the harder it is to remember the same percentage as when a smaller number of tasks is scheduled, regardless of the intervention used.

Everyday tasks requiring EM were identified using wall charts, diaries and other resources currently used by the participants. These tasks were entered onto the weekly task identification form (Appendix 4) and daily task completion confirmation forms (Appendix 5). Participants and their caregivers, where appropriate, were instructed on how and when to complete the daily task completion confirmation forms. 'Taking medication' was not a task that was identified or included in the study at any time[6].

An instruction sheet outlining the purpose, procedures, and the assistance required from caregivers for the study were supplied to all the caregivers involved, and/or caregivers were included in the training phase. In particular, caregivers were instructed to direct participants to refer to the aids normally used, such as wall charts, when necessary, rather than instructing them on what activity or task is scheduled. Further prompts were provided only when they failed to identify or engage in scheduled tasks. Prompts given were recorded on the daily task completion confirmation form. This was done to ensure that participants' EM functioning, and not the EM of their caregivers, was recorded during the study. Baseline data collection then commenced for each participant and continued until a stable baseline was observed. Participants were instructed to use the strategies that they normally use to help them remember. The researcher met with four local participants on a weekly basis, and with one participant residing in another city on a fortnightly basis to schedule tasks during baseline and the experimental phases

[6] "Taking medication" was viewed as a critical task with potentially adversive consequences if forgotten. Participants were instructed to rely on those strategies normally used to serve as reminders to take their medication.

of the study. A research assistant met with one participant, not seen by principal researcher, on a fortnightly basis.

Training Phase

Participants were provided with a Nokia 5500 Sport mobile phone, and with a pre-pay airtime card valued at $20. They received a $20 pre-pay airtime card every two weeks for a total of eight weeks. During the training phase participants were assisted to confidently use the software, Papyrus that had been pre-installed on the phone. A task analysis of how to use Papyrus was completed and was compiled into a training/user manual (Appendix 6). Each participant was also provided with cue cards on a key ring outlining a shortened version of the steps involved in using Papyrus. Each step of entering a sample task was first demonstrated by the researcher, followed by the participant entering a task while referring to each step as outlined in the User/Training Manual and with verbal instructions from the researcher. The participants were then asked to state each step prior to entering data on the phone, and only to proceed once the researcher confirmed that the step was correct, tasks were then entered with the participant referring to the steps outlined in the manual only. This was repeated until the participant could enter tasks independently, using the manual or cue cards when needed. This was followed by compiling a list of tasks and reminders that was programmed onto the mobile phone during the evaluation phase. Participants and their caregivers, where appropriate, were assisted with entering these tasks using the phone and/or the accompanying software on a personal computer. These tasks served as outcome measures. Participants were able to add, change or remove tasks by means of either the phone or a personal computer at any stage during the study. Time taken to complete the training varied between participants from one hour to eight hours.

Treatment Phase

During the first evaluation phase (A1), participants were asked to record on a form (Appendix 5) how often they complete the tasks on their list, applying those strategies that they normally use. Each participant was issued with a mobile phone once a stable baseline was observed. Each participant kept the phone for a period of two weeks (B1). This was followed by another two-week period, at the beginning of which participants were required to return the phone (A2), and recorded on a form how often they completed the tasks on their personalized list without the use of the phone. The mobile phones were then returned to participants (B2) for a further two weeks use of Papyrus. Follow-up (FU) data were collected over a period of two weeks, one month later. Each phase is fully described below:

Participants were given a mobile phone for a period of two weeks. The items on their list of tasks were entered in Papyrus. Reminders automatically sounded, at the appropriate time to alert participants to the task. Alarm times varied from 5-minutes to 1 hour before the tasks were due to be executed. Alarms were repeated at 5-minute intervals, until stopped by the participant. Participants were instructed to stop the alarm only when they had started to complete the task. A daily task confirmation form was completed towards the end of each day. Participants were asked to use those strategies normally used during the baseline phases, and to use the mobile phones only during the experimental phases. This was done to enable measurement of the efficacy of a reminder scheduling programme on a mobile phone, and not of a combination of this system and other strategies. However, their caregivers were asked to prompt the participants if they did not remember a particular task, even though a reminder was presented with the phone, and to record these incidences onto the data sheets. Caregivers confirmed accurate data recording when possible.

This was followed by a two-week return to a baseline phase. Participants recorded on a form how often they completed the tasks without the use of the phone, and with the strategies that they used during the initial baseline phase to assist with remembering. The phones were then returned to the participants for a further two weeks during which they used the phones to help them remember the tasks on their lists, and recorded accurate task completion on the task completion confirmation form, as before.

Follow-up data were collected one month later for two weeks, during which participants used the strategies as normally now used: the phone or a combination of the phone and other strategies. The mobile phone became the property of each participant upon completion of the follow-up phase. This ensured that strategies learnt during treatment remained available to participants. They were informed that the researcher was available to assist with the phone and software until the end of the calendar year. Beyond that, software support and updates remain available on SBSH Software's website address (www.sbsh.com). Participants were provided with this address, as well as with the website address for Nokia phone and software updates and support (www.nokia.co.nz).

RESULTS

Single case studies

Case Study One

Participant One (P1) a 44-year-old male had sustained a brain injury following a hypoxic event that occurred after a bone marrow procedure one-year earlier. While recovering from the procedure, but still under anaesthetic, his oxygen levels fell, requiring resuscitation and high levels of oxygen. He was discharged home to the care of his wife.

The resulting cognitive and emotional difficulties significantly impacted on his functioning. Neuropsychological assessment at five months post-injury showed IQ values in the average range, which does not represent a significant decline from his premorbid level of functioning. Specific difficulties identified in formal neuropsychological and neuropsychiatric assessments included fatigue; insomnia; increased anxiety (related to novel situations and those conducive to cognitive overload); reduced frustration tolerance; impaired impulse control; slowed information processing speed; impaired sustained, divided and alternating attention; reduced attentional and concentration capacity; motivation and initiation difficulties; impaired immediate, and delayed verbal and visual memory, (with predominantly encoding difficulties); and impaired learning. Although his executive functions were reported to be intact, other cognitive difficulties impacted on his ability to plan. In addition, he reported difficulty with his short-term and every day memory, impaired multi-tasking ability, impaired habitual learning, word finding difficulties, problems with emotional regulation, and an impaired ability to problem solve. His difficulties were consistent with hypoxic damage.

P1 reported recent improvements with regulating his emotions, and his ability to concentrate. He was expecting further spontaneous recovery, but recognised that he would have residual difficulties. He hoped to return to 80% of his formal level of functioning. He had been unable to work for the last year, but was slowly working his way towards re-entering paid employment. He received assistance from an Occupational Therapist, which he viewed as very helpful.

Strategies to assist P1 to compensate for his memory and organizational difficulties and his sleep problems had been put in place prior to his inclusion in the present study. These included planning his weekly schedule with his wife, using a wall-chart, and using his mobile phone to set up reminders. However, the functions on his phone are very limited. For example, he could only set-up one reminder per day. He appeared to be exceptionally motivated to recover and to return to gainful employment. He had retained a good sense of humour and was optimistic about the prospect to use a mobile phone to assist with his recovery and to compensate for his residual difficulties. He had a good level of insight into his problems and realistic expectations of what the study could contribute. He had completed secondary school up to 4th form, owned a mobile phone and a home computer, and had access to the internet from home.

Memory Aids Questionnaire:

P1 reported that he currently used 10 strategies to assist with remembering, which ranged from rarely useful to usually useful. He used no memory strategies before his injury. His results are outlined in Table 10.

Table 10
Strategies used to assist with remembering - P1

Strategy	Use pre-injury[7]	Use post injury	Usefulness post injury
Daily routine	Never	Always	Usually
Weekly routine	Never	Always	Usually
Notes on a wall chart	Never	Always	Usually
Lists	Never	Always	Sometimes
Appointment diary	Never	Always	Very
Ask other to remind me	Never	Always	Sometimes
Repetitive Practice	Never	Always	Sometimes
Mobile phone alarm function	Never	Sometimes	Sometimes
Mobile phone voice calls	Never	Sometimes	Usually
Associations	Never	Sometimes	Rarely

Patient Competency Rating Scale:

Discrepancies between P1's and his caregiver's ratings on the PCRS were in the areas of emotional and interpersonal functioning, and in ADL with an overall point difference of 22 (14.7%). P1 underestimated his interpersonal functioning[8] and his ability to engage in self-care activities. His overestimated his ability to control his emotions.

[7] It is unlikely that P1, P2, and P3 Never used any reminding strategies. They may have overestimated their pre-injury ability to remember tasks.
[8] It may be that P1 disguised his interpersonal discomfort or that his caregiver did not notice his discomfort (see. Leathem, Murphy, & Flett, 1998).

Shapiro Control Inventory:

P1's overall sense of control was below that typically found with healthy people. His general level of self-efficacy (positive sense of control) was lower than that of the normative group. This indicated that he did not have their level of belief that he had the resources to achieve and maintain control in his life.

He reported that his sense of control coming from his own efforts to an extent less than a normal group, and a sense of control coming from others to an extent comparable to or higher than that of healthy normals. This suggests that he felt too depended on others, to the exclusion of his own efforts.

Baseline (A1)

P1 had 24 activities scheduled during week one of baseline. These included appointments, housework, feeding the animals, volunteer work, and completing the data recording sheets. Most of these tasks were repeated and each recurrence was counted as one activity. He completed 13 activities. Six activities were cancelled due to a change in his schedule, and he forgot to complete five activities at the planned time (completing the data recoding forms). He completed these five activities at the end of the week. He received three reminders from others, used his diary on eight occasions, and used his wall chart once. He remembered to complete his data recording sheets upon seeing the folder containing the sheets in his bookshelf once.

He had 36 activities scheduled during week two of baseline, including appointments, housework, gardening, feeding the animals, and completing the data recording sheets. As during week one, many of these activities were repeated on different days and each recurrence counted as one activity. He had forgotten to complete three activities, and cancelled six activities. He completed 27 activities, all of which he remembered with the aid of his dairy.

Over the entire baseline period, P1 successfully remembered to complete 37 activities with the various strategies used to assist with remembering, excluding prompts from others (62%). He had forgotten to complete 8 activities (13%), and received prompts from others 3 times (5%) and did not remember any activities independently (0%).

Treatment Phase One (B1)

During this phase, P1 had 41 activities scheduled, including housework, visiting friends, appointments, fixing fences, golf, and feeding the animals. He cancelled four activities and completed 37. Of the 37 activities, he used the phone alone on 36 occasions (97%) and his diary once to assist with remembering. He remembered all 37 activities at the intended time (100%).

Return to Baseline Phase (A2)

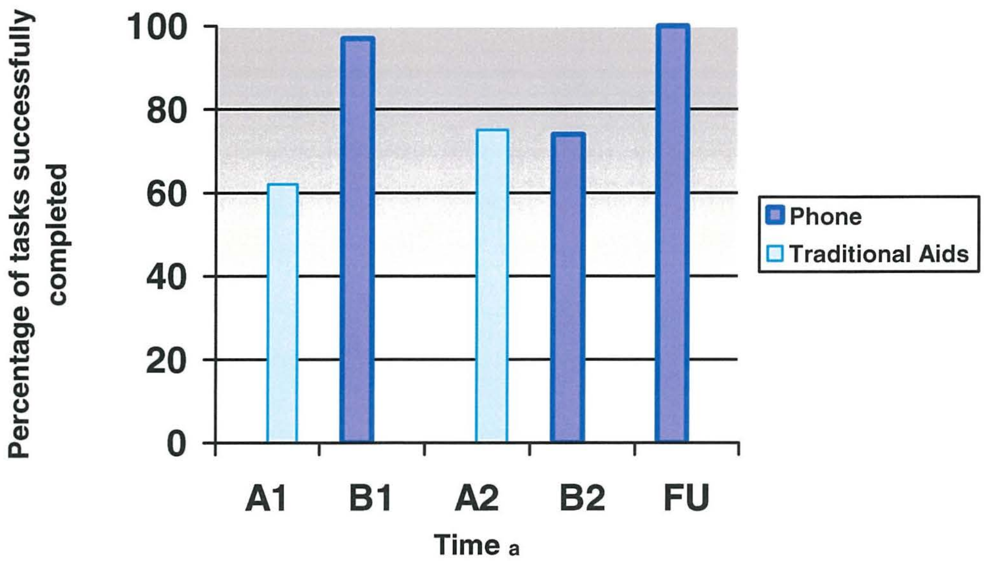
P1 had 26 scheduled activities during the return to baseline phase. This phase was repeated because P1 was admitted to hospital during this phase, where he was diagnosed as experiencing stress-related amnesia. Over the two weeks after recovering from the amnesic event and discharge from hospital, P1 had 32 activities scheduled, of which he remembered 10 activities himself (31%), had 8 (25%) reminders from others, and used his diary 14 times (44%).

Treatment Phase Two (B2)

P1 completed 35 of 42 scheduled activities during this phase. Seven were cancelled or rescheduled. The activities included housework, feeding the animals, appointments, and golf. He used the phone for all 35 activities and remembered 9 before the alarm on the phone sounded. Overall he remembered all activities (100%).

Follow-up Phase (FU)

P1 had 49 activities scheduled during the two week follow-up phase, including housework, appointments, and leisure activities. He successfully completed all 49 activities (100%) with the use of his phone. He did not require any prompts from others during these two weeks. P1's results are presented in Figure 4.



[a] Data points without both bars indicate that that one or both types of aids were not used at all.

Figure 4. Percentage of tasks successfully completed using the phone vs. traditional aids (excluding reminders from others)[9] - P1

P1 demonstrated moderate ability to complete activities at baseline. He made good use of traditional remembering strategies, and relied mostly on the use of his diary, and prompts from his caregiver. His task completion rose to 97% at B1 while using the phone. He required prompts from others often during the return to baseline phase. He used the phone 74% of the time during B2 and remembered the remaining 26% of tasks before the phone alarm sounded. He did not rely on any other strategy during B2. He reported using his phone 100% of the time at one-month follow-up.

[9] Reminders from others were excluded to obtain a measure of the number of tasks the participant, and not their caregiver, could remember,

Case Study Two

Participant Two (P2) was a 22-year-old male, who sustained a traumatic brain injury in a motor vehicle accident six years ago. He had a GCS of 3 upon admission to hospital. An initial computed tomography scan (CT) showed left frontoparietal subdural haematoma and underlying haemorrhagic contusion, diffuse cerebral oedema and a large amount of subarachnoid blood. A later CT showed a left occipital infarct and diffuse cerebral oedema. Posttraumatic amnesia (PTA) was present until approximately five and a half months post injury. He reported retrograde amnesia dating back to when he was nine or ten years old. All of these factors indicate an extremely severe brain injury. He was in the intensive care unit, and underwent six weeks of inpatient care, before transfer to a hospital-based rehabilitation unit. With a GCS of 14, he was discharged to a community- based brain injury rehabilitation service, where after he remained for one year as an inpatient until a recent move to supported accommodation, where he still receives attendant care for 12 hours per day, seven days per week.

Neuropsychological assessment identified difficulties in the following areas: impaired concentration, recent memory, learning and information retention, executive functioning, and visuoperceptual abilities at 6-months post-injury. Although P2 had STM difficulties and low tolerance for distraction, his task performance improved in a structured, organized, and distraction free environment. He had auditory hallucinations and reduced impulse control at 7 months post-injury and reported persistent physical problems, including double vision. Relevant facts from P2's history include pre-injury diagnosis of Tourette's syndrome at 13-years-old, with verbal and motor tics. He reported that the verbal tics have reduced following treatment with biofeedback techniques.

During the interview P2 presented with some anosognosia (lack of awareness of deficits) due to frontal lobe damage and other injury-related deficits. Although he noted improvements, he reported difficulties with attention and concentration, short-term memory, mispronouncing words, and reading. Earlier confusion and emotional regulation difficulties had resolved, and his orientation to time and place improved. He also viewed his sleep difficulties as resolved although he still slept during the day on occasion. He did not report any changes in personality, but this was inconsistent with corroborative information. He described himself as outgoing and sociable, and belonging to a good social circle. He was receiving assistance from his parents with managing his savings. He received a daily allowance to purchase small items, such as cigarettes. His main self-reported concern was everyday memory difficulties.

P2 hoped to gain increased independence by taking responsibility for his daily schedule and self-initiating activities. He resisted the use of some techniques such as wall charts to assist him with organising his day. He did use the calendar function on his mobile phone to assist with some activities, but this was mainly limited to appointments. He relied mostly on his caregivers to provide him with ongoing prompts and reminders of his scheduled activities. He completed secondary school up to 6th form (10 years of formal schooling). He owned a mobile phone and a home computer.

Memory Aids Questionnaire:

P2 reported using 17 strategies to assist with remembering. These comprised 5 electronic memory aids and 12 non-electronic strategies. He reported that he used no strategies to assist with remembering premorbidly. Of the strategies used, he rated using his pill box, asking others to remind him, and mobile phone text messages as the most useful to help him remember, and placing objects in unusual places, orientation of medication, mental retracing, repetitive practice, and chunking information as least useful. These results are summarized in Table 11.

Table 11
Strategies used to assist with remembering - P2

Strategy	Use pre-injury	Use post injury	Usefulness post injury
Mobile phone text messages	Never	Always	Very
Pill box or blister pack for medication	Never	Always	Very
Asking others to remind me	Never	Always	Very
Instructions for activities	Never	Always	Sometimes
Lists	Never	Often	Sometimes
Weekly routine	Never	Often	Usually
Mobile phone voice calls	Never	Often	Usually
Mobile phone picture messages	Never	Sometimes	Sometimes
Mobile phone alarm function	Never	Sometimes	Sometimes
Daily routine	Never	Sometimes	Usually
Mobile phone calendar function	Never	Rarely	Never
Placing objects in unusual places	Never	Rarely	Never
Orientation of medication	Never	Rarely	Never
Mental retracing	Never	Rarely	Never
Repetitive practice	Never	Rarely	Never
Home computer	Never	Rarely	Never
Chunking information together	Never	Rarely	Never

Patient Competency Rating Scale:

Discrepancies between P2's and his caregiver's ratings on the Patient Competency Rating Scale (PCRS) were in the areas of organisational skills, memory, and emotional functioning. P2 viewed his ability in these areas to be less impaired than his caregiver. Even then it is likely that the caregiver overestimated P2's functioning as he had only known him for a short while. This was confirmed by

P2's mother[10], who expressed concerns about his level of insight and his resistance to participate in rehabilitation efforts. P2 moved to a brain injury rehabilitation unit during this study with the aim of increasing his level of insight and acceptance into his difficulties.

Shapiro Control Inventory:

P2's overall sense of control was similar to that typically found with healthy people. This indicated that he generally believed that he had the resources to achieve and maintain control in his life. His general level of self-efficacy (positive sense of control) was lower than that of the healthy normal comparison group.

Baseline (A1)

P2 had 15 activities scheduled during week one. These included appointments, going to the gym, rock-climbing, preparing lunch, housework, and grocery shopping. Various tasks, such as going to the gym and housework were repeated on particular days. Each repeat was recorded as one activity. P2 successfully completed seven activities. Eight activities were not completed for a range of reasons including changes in his schedule, him refusing to do some tasks, and not having enough money to cover the cost of an activity such as rock-climbing. Of the seven activities completed, he needed verbal prompts from his caregiver on three occasions. His caregivers prompted him to utilize his wall chart to identify the next scheduled activity. On occasion when he failed to or refused to use his wall chart, his caregivers reminded him what activity was to be completed. He received two text-message prompts to remind him to attend meetings, and he remembered to prepare meals because he was hungry. He failed to complete the tasks without prompts, or to self-initiate the use of his wall chart 100% of the time.

He had 13 activities scheduled during week two. These included waking up in the morning, going to the gym, shopping, going cycling, going to work as a volunteer,

[10] Although it would have been preferable to obtain the PCRS-R information from P2's mother, she was not available to participate in the study. She temporarily moved closer to assist P2 only toward to end of the study.

going rock climbing, and housework. He successfully completed 9 activities. For the remaining four activities, he refused to engage in two activities, again lacked sufficient funds for rock climbing, and had a change in his schedule that prevented him form completing one activity. For the 9 completed activities, P2 received three phone reminders from his caregivers, 5 face-to-face verbal reminders, and one phone reminder followed by a verbal reminder. P2 failed to self-initiate the use of his wall chart 100% of the time.

Baseline data collection was repeated because P2 had significant changes in his living situation and schedule[11]. Over the two week period he had 40 activities scheduled, of which he received prompts from others 100% of the time.

Treatment Phase One (B1)

For this phase five tasks per day over 10 days[12] were scheduled, adding to 50 activities. Of these he did not complete 10 activities (going to the gym) due to changes in his schedule. Of the remaining 40 activities, he reported remembering 24 (60%) with the use of his phone (making breakfast, dishes, making dinner), receiving prompts from others 6 times (15%) and forgetting 10 (25%; completing the data collection forms). These were completed retrospectively with the aid of his mother. Although he remembered 30 activities, he failed to complete most.

Return to Baseline Phase (A2)

In the return to baseline phase, P2 had the same 5 activities scheduled each day over 10 days. He did not go to the gym during the two weeks, and these 10 activities were not used in calculations. Of the remaining 40 activities he did not remember any independently (0%), received 22 prompts from others (55%), and

[11] P2 moved from supported accommodation with full-time care, to live with his father. He had a change in caregivers, and had less responsibility to complete any tasks. He then moved to live with his mother, without further assistance from caregivers. After this he moved to a community-based rehabilitation facility, where he remained for a few weeks only.

[12] Changes in P2's living arrangements prevented him from completing tasks on Saturdays and Sundays.

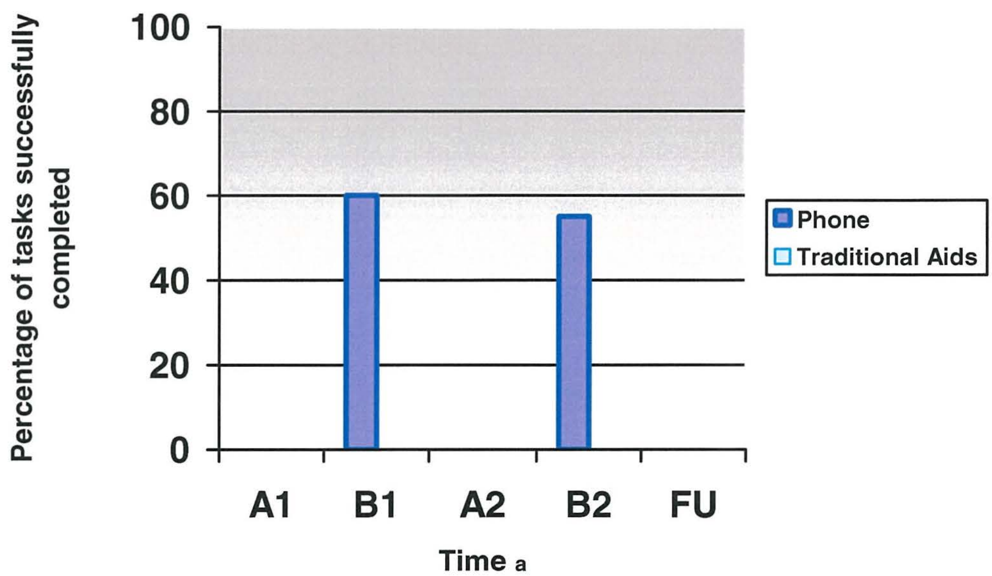
forgot to complete 18 activities (45%). Again receiving prompts from others did not translate into him actually performing the tasks.

Treatment Phase Two (B2)

Again the same 5 activities were completed over 10 days. He did not complete 10 activities due to changes in his schedule. Of the 40 remaining tasks, he used his phone 22 times (55%), used a visual prompt once (2.5%), and received reminders from others 7 times (17.5%), and did not complete 10 activities (completing the data recording forms). These were completed retrospectively with the aid of his mother.

Follow-up Phase (FU)

P2 was not available for the follow-up data collection[13]. His results are depicted in Figure 5.



[a] Data points without both bars indicate that that one or both types of aids were not used at all. No data was available for FU.

Figure 5. Percentage of tasks successfully completed using the phone vs. traditional aids (excluding reminders from others) - P2

[13] P2 left the community rehabilitation facility without providing a forwarding address. His parents also moved without a forwarding address.

P2 demonstrated very impaired ability with remembering tasks at baseline. He refused to / was unable use any traditional strategies. He relied on his caregivers to remind him of all scheduled tasks. His memory for tasks rose to 60% at B1 and 55% at B2. Although he remembered the tasks, his caregivers reported that he did not actually complete many of them. P2 presented with the consequences of a very severe brain injury, poor insight into his difficulties, and emotional / mental health difficulties, including Tourette's syndrome and oppositional defiant behaviours (diagnosed prior to his TBI), which may account for his resistance to complete tasks.

Case Study Three

Participant Three (P3) a 25-year-old male had sustained two brain injuries. He sustained his first injury seven years earlier in an assault during which he was kicked in the head. Neuroimaging revealed a basal skull fracture and he had a left temporal craniotomy and evacuation of a haematoma. He was discharged from hospital one week after the surgery and early rehabilitation efforts were reportedly unsuccessful. His main concerns at that time were behavioural difficulties and aggression, which gradually improved but did not fully resolve. The second injury resulted from a motorcycle accident 10 months before the present research. His GCS score at the scene was 3/15. He was admitted to intensive care where he remained in a coma for seven days. He had no recollection of the accident and reported PTA of two weeks after regaining consciousness in hospital. He reported retrograde amnesia of three weeks, with large gaps in his memory of childhood, as well as ongoing EM difficulties.

P3 reported difficulties with emotional regulation, fatigue, mood disturbances, including depression and anxiety, low frustration tolerance, EM, long-term memory, attention and concentration, and confusion mostly after he wakes up. He had slowed down from his pre-morbid level of stamina and energy, and had sleep disturbances that were controlled through medication. P3's psychologist reported unusual ongoing difficulties related to vision, (processing what he sees, visual perception), impaired fine motor skills, ability to multitask, and forgetfulness. She commented that P3 learned best from his own mistakes and that his aggression has lessened subsequent to his second injury. Neuropsychological assessment identified difficulties with complex attentional functioning, new verbal learning and memory, and abstract reasoning. His performance on tests of other cognitive functions was in the average range. The examiner reported some qualitative indicators of executive functioning difficulties.

P3's caregiver left notes throughout the house and made phone calls to remind him of his scheduled activities. P3 appeared very motivated to learn to use the mobile phone in order to increase his level of independence. He completed three years of secondary school. P3 owned a mobile phone and home computer. He did not have access to the internet or owned a pager.

Memory Aids Questionnaire

He used eight strategies to assist with remembering. These were all non-electronic aids, including asking others to remind him (often), using lists (sometimes) and a daily routine (rarely), placing objects in unusual places (often), using an organizer briefcase (often) and blister pack for medication (often), as well as mental retracing (rarely) and chunking information together (rarely). He reported using six strategies of these eight strategies before his injury. The two strategies not used premorbidly were asking others to remind him and chunking information together. He currently rated asking others as the most helpful and mental retracing as the least helpful. Table 12 outlines these strategies and their perceived usefulness, as rated by P3.

Table 12

Strategies used to assist with remembering - P3

Strategy	Use pre-injury	Use post injury	Usefulness post injury
Asking others to remind me	Never	Often	Usually
Lists	Sometimes	Sometimes	Sometimes
Daily routine	Rarely	Rarely	Rarely
Placing objects in unusual places	Rarely	Often	Sometimes
Organizer briefcase	Sometimes	Often	Sometimes
Pill box or blister pack for medication	Sometimes	Often	Usually
Mental retracing	Rarely	Rarely	Rarely
Chunking information together	Never	Rarely	Rarely

Patient Competency Rating Scale

There was a 28 point difference (19%) between P3 and his caregiver's ratings on the PCRS, especially the areas of organisational skills, memory, and emotional functioning. He viewed his memory, emotional and organisational deficits to be less problematic than his caregiver. Social acceptance was very important to him, which contributed to his reluctance to try some techniques such as wall charts to assist him with organising his day. He mostly relied on his caregiver to remind him of his activities both by writing daily notes for him and by phoning him numerous times per week to remind him of scheduled appointments and tasks.

Shapiro Control Inventory

P3 reported having a healthy sense of control in his life. His general level of self-efficacy (positive sense of control) was in the healthy normal range. He reported an appropriately balance between self-efforts to gain a sense of control and the efforts from others.

Baseline (A1)

P3 completed two weeks of baseline data collection. He had 30 scheduled activities during this phase, including appointments, errands, housework, gardening, shopping, and visiting friends. He rescheduled or cancelled 3 activities. Of the remaining 27 activities, he independently remembered 5 (19%), received 20 reminders (74%) from others by phone, text messaging or notes left for him, and forgot 2 activities (8%).

Treatment Phase One (B1)

He had 26 activities scheduled during the two week phase, including appointments, housework, errands, and going to the gym. Three activities were cancelled. Of the remaining 23 activities P3 remembered 4 (18%) without any reminders, 16 with the use of the phone (70%), and 3 (13%) reminders from others.

Return to Baseline Phase (A2)

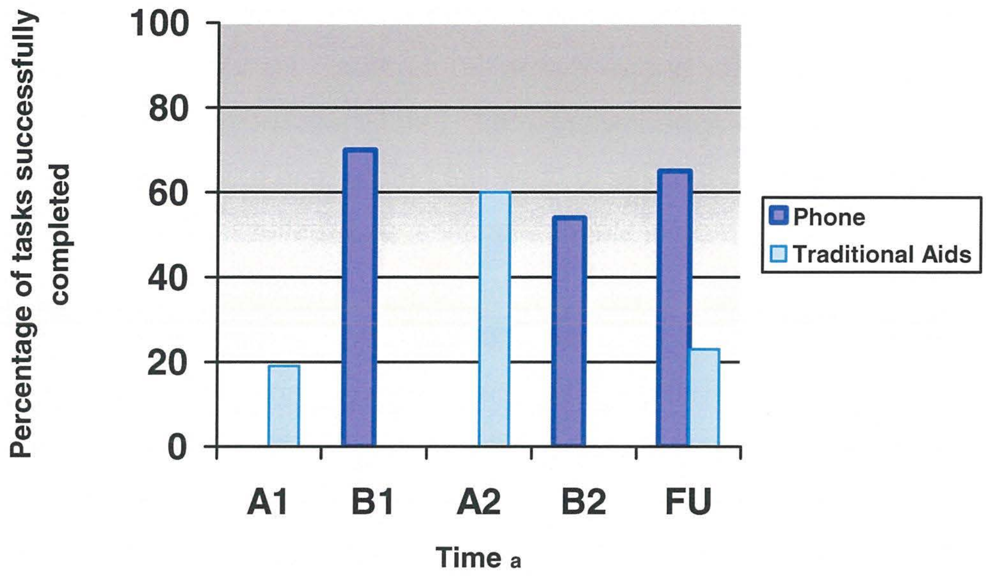
Thirty four activities were scheduled, and nine of these were cancelled. Of the remaining 25 activities, he independently remembered 15 (60%) and needed prompting 7 times (28%). He forgot 3 activities (12%). The following phase was delayed for one week as he recovered following a suicide attempt (unrelated to his participation in this research) and a change in his medication regime.

Treatment Phase Two (B2)

P3 had 13 activities scheduled during this phase. He used the phone on seven occasions to assist with remembering (54%), he forgot an activity once (8%), received three prompts (23%), and remembered an activity independently twice (15%).

Follow-up Phase (FU)

The follow-up phase commenced four weeks after the completion of treatment phase B2. P3 had 17 activities scheduled including appointments, errands, housework and socializing. He completed all 17 activities. He used the phone 11 times (65%) to assist with remembering, received prompts (notes from others) on two occasions (12%), and remembered without using an aid four times (23%). His results are presented in Figure 6.



[a] Data points without both bars indicate that that one or both types of aids were not used at all.

Figure 6. Percentage of tasks successfully completed using the phone vs. traditional aids (excluding reminders from others) - P3

P3 demonstrated poor ability to complete tasks at baseline, using traditional aids to remember. He relied heavily on prompts from others. He remembered habitual tasks, such as housework tasks, more independently during all phases of the study. This is reflected in the relatively higher score during the return to baseline phase. His overall performance while using the phone showed an improvement in his ability to complete tasks from baseline. However, he performed slightly worse during B2 than A2. This may be due to him having suffered emotional difficulties and an ensuing break in the study while he recovered (before B2). He showed a great improvement in his ability to complete tasks from baseline to follow-up, when he used his phone 65% of the time. His reliance on others to remind him had halved by follow-up.

Case Study Four

Participant Four (P4), a 42-year-old Maori male, had sustained a moderate brain injury in a pedestrian vs. car accident one year earlier. He reportedly lost consciousness for approximately 90 minutes. He was hospitalized for one month during which he appeared agitated. Later there were difficulties with concentration, forgetfulness, an inability to draw like before, and indecisiveness. He also reported depressive symptoms, sleep difficulties, and restlessness.

Relevant aspects of P4's prior medical history include an accident during which he was crushed between 800 tonnes of railway wagons for a few seconds sustaining back injury; a car accident 16 years earlier that resulted in a left-frontal head injury with no apparent mood or cognitive difficulties; and an accident in which he fell hitting his head on the footpath resulting in nerve damage. Formal neuropsychological assessment revealed impaired simple auditory attention, visual perceptual and fine motor skill difficulties, impaired memory for auditory information with encoding difficulties, and poor cognitive flexibility in the visuomotor domain of functioning. He reported difficulties with EM functioning. He has used a mobile phone to assist with remembering before, but his phone had limited functions and had broken recently. At the start of this study he used a wall chart, diary, and writing notes on his hand. He completed 3 years of secondary school. He does not own a pager or home computer, but does own a mobile phone. He did not have access to the internet during this study.

Memory Aids Questionnaire

P4 used 16 strategies to assist with remembering; of which 4 were electronic and 12 non-electronic strategies. He used mobile phone voice-calls and mobile phone text-messages "often", and mobile phone alarm function and mobile phone alarm function "always" (for every reminder). He "rarely" used leaving objects in usual places and orientation of medication. He "sometimes" used a weekly routine, pocket phone book, organizer briefcase, alarm clock, and mental retracing. He "often" used a daily routine, notes on a wall chart, and asking others to remind him. He "always" used lists and his appointment diary. He rated using an organizer bag, placing objects in unusual places, and orientation of medication as the least helpful ("rarely"); mobile phone voice calls, a daily routine, a weekly routine, a pocket phone book, an alarm clock, and mental retracing as "sometimes useful"; mobile phone text messages, notes on a wall chart, and asking others to remind him as "usually useful"; and the mobile phone alarm and calendar functions, lists, and an appointment diary as "very useful". He used 14 strategies prior to his injury. "Rarely" used strategies were mobile phone voice calls, text messages, alarm function, and calendar function, notes on a wall chart, lists, pocket phone book, asking others to remind him, placing objects in unusual places, an alarm clock, and mental retracing. He "sometimes" used a daily routine, weekly routine and appointment diary before his injury. These results are presented in Table 13.

Patient Competency Rating Scale

Discrepancies between P4 and his caregiver's ratings on the Patient Competency Rating Scale (PCRS) were in the areas of daily living skills, interpersonal skills, and memory (overestimations), and to a lesser degree emotional functioning (underestimation). The average difference across all 30 items between P4 and his caregiver's ratings was 4.67%.

Shapiro Control Inventory

P4's overall sense of control was similar to that typically found with healthy people. His general level of self-efficacy (positive sense of control) was in the healthy normal range. This indicated that similarly to healthy normals he believed that he had the ability and resources to achieve and maintain control in his life. He reported experiencing his sense of control coming from his own efforts to lesser extent than a normal comparison group, and that he relied on others too much.

Table 13
Strategies used to assist with remembering - P4

Strategy	Use pre-injury	Use post injury	Usefulness post injury
Mobile phone alarm function	Rarely	Always	Very
Mobile phone calendar function	Rarely	Always	Very
Lists	Rarely	Always	Very
Appointment diary	Sometimes	Always	Very
Mobile phone voice calls	Rarely	Often	Sometimes
Mobile phone text messages	Rarely	Often	Usually
Daily routine	Sometimes	Often	Sometimes
Notes on a wall chart	Rarely	Often	Usually
Ask other to remind me	Rarely	Often	Usually
Weekly routine	Sometimes	Sometimes	Sometimes
Pocket phone book	Rarely	Sometimes	Sometimes
Organizer briefcase	Never	Sometimes	Rarely
Alarm clock	Rarely	Sometimes	Sometimes
Mental retracing	Rarely	Sometimes	Sometimes
Place objects in unusual places	Rarely	Rarely	Rarely
Orientation of medication	Never	Rarely	Rarely

Baseline (A1)

He had 26 activities scheduled during the two week baseline phase and completed 25 activities, (one was completed by a family member when he forgot). His activities included housework, errands, appointments and completing the data forms. Strategies used were reminders from others (n = 15), using his dairy (n = 2), and using multiple strategies including reminders from others, his diary, notes in special places, and his phone (n = 8). He did not remember any activity independently (0%).

Treatment Phase One (B1)

Fifty five activities, including housework, shopping, appointments, feeding the pet, cooking a meal, paying bills, errands, and completing the data forms were scheduled during this treatment phase. He completed 52 tasks, two were cancelled, and one completed by a family member. Of the 52 tasks he used his phone to remember (n = 36), his phone and his diary (n = 10), and his phone followed by a reminder from others (n = 6). He successfully remembered activities with the use of the phone alone 69% of the time, his phone and his dairy 19% of the time, and his phone followed by reminders from others 12% of the time.

Return to Baseline Phase (A2)

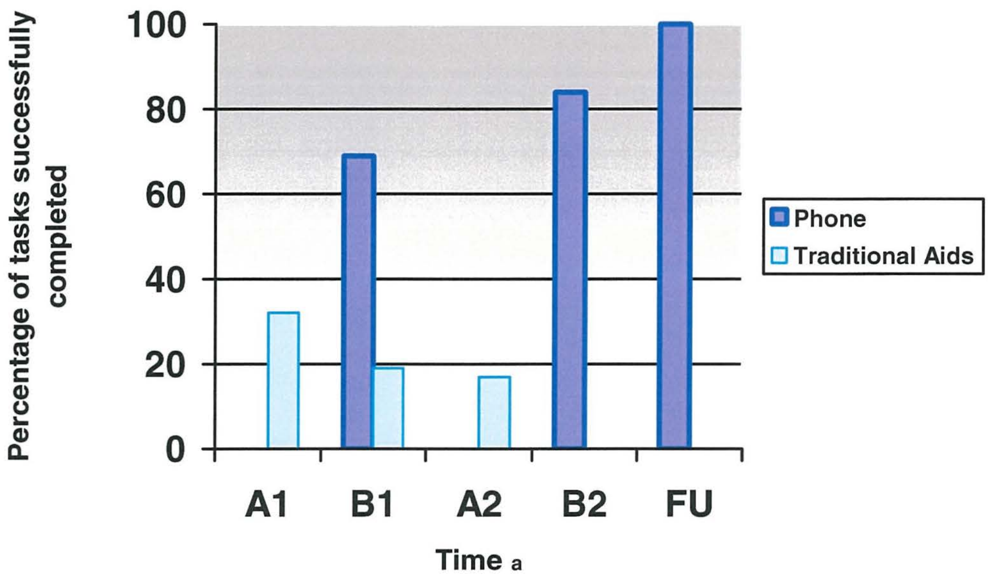
P4 had 60 activities scheduled during this phase. These included feeding the pet, housework, watering the plants, preparing meals, appointments, and completing the data forms. He completed 57 activities. Two were cancelled and one completed by a family member. He had 39 (68%) reminders from others, and used his diary combined with reminders from others on 17 (30%) occasions, and forgot one activity (2%). He did not independently remember any of the scheduled activities (0%).

Treatment Phase Two (B2)

He had 46 activities scheduled over two weeks. These included tasks around the house, childcare, preparing meals, meetings, and completing the data collection forms. He used his phone 38 times (84%), had one reminder from his partner, six reminders from his children (16%), and did not complete one (cancelled appointment).

Follow-up Phase (FU)

Twenty-two activities, including housework, appointments, child-care and completing the data collection forms were scheduled over one week. He used his phone to remember these activities 100% of the time. Figure 7 provides a graphic presentation of P4's results.



[a] Data points without both bars indicate that that one or both types of aids were not used at all.

Figure 7. Percentage of tasks successfully completed using the phone vs. traditional aids (excluding reminders from others)[14] - P4

P4 demonstrated poor ability with remembering tasks at baseline and return to baseline, using traditional aids. He relied on others to remind him often. His task completion rose to 69% at B1, 84% at B2 and 100% at follow-up with the use of the phone. He had a high level of insight into his difficulties, and a level of self-efficacy in the normal range. Participants were instructed not to use those aids normally used during the treatment phases of the research. However, his caregiver was instructed to provide prompts when needed. He required less prompting while using the phone, than when using traditional aids. The ratio of prompting during the baseline phase and the return to baseline phase remained the similar, with about one half of the tasks requiring prompts from others.

[14] Although instructed not to use other strategies during the treatment phases, P4 used his diary during B1.

Case Study Five

Participant Five (P5) a 26-year-old woman had sustained a serious brain injury in a motor vehicle accident two years earlier, as well as sciatic nerve damage, a comminuted fracture or the right distal radius and ulna, and fractures to the right acetabulum and bilateral pubic rami. She was knocked unconscious during the accident, and remained in an induced coma for three weeks. Her brain injury resulted from two mechanisms: one relating to a frontal haematoma evidenced upon neuroimaging and the second relating to a hypoxic event secondary to a ruptured aorta. She had no memories for events for one to two weeks prior to the injury, or for eight weeks post injury, and even then her memories were vague and patchy. She had more continuous memory for events from about seven months post injury.

According to a neuropsychological assessment conducted nine months after the accident her memory problems were assessed to be the most salient. Her memory difficulties did not seen to simply a reflection of attentional dysfunction. Her pattern of performance on neuropsychological measures suggested damage to mesial temporal structures involved in the formation of new memories. Her premorbid level of intelligence was placed in the average range. Qualitative observations of her performance on timed tests indicated significant cognitive slowing. Her psychomotor speed was not formally assessed due to a lack of dexterity of her right hand. She scored in the slightly below average range on tests of simple sustained attention. Her ability to perform complex attentional functions was well below average. Her performance on a list-learning task was very low, falling well below normal limits. Her ability to recall learnt material after an interference trial and after a delay was also well below average. Her recognition memory for auditory presented material was well below average, as was her ability to reproduce geometrical material. Her visuospatial and visuoconstructional abilities were in the normal range. Her performance on measures of executive functioning was variable, verbal abstract reasoning in the low average range, but intact flexibility in problem solving and verbal fluency ability. However, she became overwhelmed when presented with a large amount of information, and had difficulty with organizing complex material into a more manageable form. Her ability to inhibit a habitual response was poor and she failed to identify and correct her own errors.

Other ongoing difficulties include fatigue, an increased need for sleep, uncharacteristic irritability, sciatic nerve palsy manifested in right foot drop and sensory disturbances, and loss of finger dexterity. She used a wall chart, notice board, and verbal reminders from others to assist with remembering. She completed ten years of schooling and a polytechnic certificate. She did not own a pager, but did own a mobile phone and a home computer, although without access to the internet.

Memory Aids Questionnaire

P5 used 12 strategies to assist with remembering post-injury and 7 pre-injury. Strategies "always" used post-injury were mobile phone text messages, mobile phone calendar function, notes on a wall chart, and lists. Strategies "often" used were the mobile phone alarm function, a daily routine, a weekly routine, asking others to remind her, mental retracing, repetitive practice, and chunking information together. She also "rarely" used mobile phone voice calls to assist with remembering. Rated as "very useful" were mobile phone voice calls, text messages, alarm function and calendar function; notes on a wall chart, lists, a daily routine, a weekly routine, and asking others to remind her. Repetitive practice was rated as "usually useful", and mental retracing and chunking information together as "sometimes useful". Before her injury, she "always" used home filing and an organizer handbag, "often" used mobile phone voice calls and text messages, and "sometimes" used placing objects in unusual places and a pillbox or blister pack to assist with remembering. She also "rarely" used mental retracing. The strategies used by P5 are summarized in Table 14.

Table 14
Strategies used to assist with remembering - P5

Strategy	Use pre-injury	Use post injury	Usefulness post injury
Mobile phone calendar function	Never	Always	Very
Lists	Never	Always	Very
Mobile phone text messages	Often	Always	Very
Notes on a wall chart	Never	Always	Very
Mobile phone alarm function	Never	Often	Very
Daily routine	Never	Often	Very
Weekly routine	Never	Often	Very
Ask other to remind me	Never	Often	Very
Mental retracing	Rarely	Often	Sometimes
Repetitive practice	Never	Often	Usually
Chunking information together	Never	Often	Sometimes
Mobile phone voice calls	Often	Rarely	Very
Organizer briefcase	Always	Never	Never
Home filing	Always	Never	Never
Pillbox or Blister pack for medication	Sometimes	Never	Never
Place objects in unusual places	Sometimes	Never	Never

Patient Competency Rating Scale

Discrepancies between P5's and her caregiver's ratings on the PCRS were in all areas of functioning. She viewed her daily living, interpersonal, memory, and emotional functioning as less problematic than her caregiver. There was an average 24 point difference (16%) between self and caregiver ratings across all 30 items.

Shapiro Control Inventory

Her overall general domain sense of control was similar to that typically found with healthy people. This indicated that she generally believed that he had the resources to achieve and maintain control in her life. Her general level of self-efficacy (positive sense of control) was in the healthy normal range.

Baseline (A1)

P5 had 70 activities scheduled during the two week baseline. Her activities included appointments, preparing meals, rest, collecting a family member daily, and completing the data sheets. Two activities were cancelled. Of the remaining 68 she forgot nine (13%). She received reminders from others (person, phone or text-messages) 24 times (35%); used her notice board on 14 occasions (21%); event-based cues on 12 occasions (18%; such as feeling fatigued or hungry around the time when meals and rest were scheduled); her phone alarm three times (4%); her phone twice (3%); a weekly routine twice (3%); and remembered herself twice (3%).

Treatment Phase One (B1)

Sixty one activities, including appointments, meals, rest, collecting a family member daily, and completing the data forms, were scheduled during this phase. Six activities were cancelled. Of the remaining 55 activities she completed 54 and forgot one (2%; when she left her phone a room where she could not hear it ring). She used the phone on 49 occasions (89%), the phone and a reminder from others twice (4%), and remembered herself three times (5%).

Return to Baseline Phase (A2)

She had 73 activities scheduled over two weeks. These comprised the same activities outlined during the earlier phases. Four activities were cancelled. Of the remaining 69 she completed 68 and forgot 1 (2%). She used a whiteboard 55 times (80%), her diary 6 times (9%), an alarm 3 times (5%), had 1 reminder from others (2%), and remembered 3 (5%) independently.

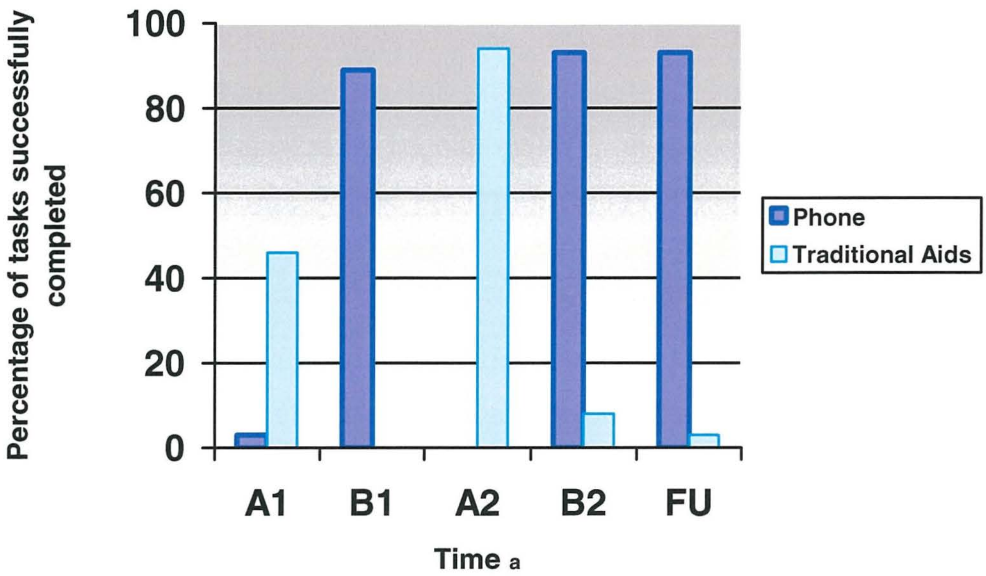
Treatment Phase Two (B2)

Fifty-four activities, including appointments, exercises and attending the gym, planning rest-periods, house work, and completing the data collection forms were scheduled over 8 days. P5 completed all activities. She used a whiteboard to remember 4 times (8%) and her phone 50 times (93%).

Follow-up Phase (FU)

She had 80 activities scheduled over nine days, of which one was cancelled. These included preparing meals, appointments, planning rest times, completing physiotherapy exercises, housework, and completing the data collection forms. Of the remaining 79, she remembered four (5%) without the use of any aids, two (3%) with event-based cues, and 73 (93%) with the use of her phone. These results are presented in Figure 8.

P5 demonstrated only moderate ability to complete tasks during baseline, often then only with caregiver prompts. Her task completion rose to 89% at B1 and 93% at B2 and follow-up. She used traditional strategies, i.e. her whiteboard, very effectively during A2. However, her caregivers were responsible for adding and organising tasks on the whiteboard. She moved house before follow-up, and lost the support from her caregivers. She continued the use of the phone with good effect.



[a] Data points without both bars indicate that that one or both types of aids were not used at all.

Figure 8. Percentage of tasks successfully completed using the phone vs. traditional aids (excluding reminders from others)[15] - P5

Case Study Six

Participant Six (P6), a 40-year-old male, had sustained a severe brain injury in a motor vehicle vs. train accident. His injuries included severe upper brainstem injury, fractured mandible, and spine and rib fractures. A CT scan also revealed evidence of diffuse axonal injury. The length of RA is unclear but possibly days to weeks before the accident. PTA was significant - probably two months.

A neuropsychological assessment conducted ten months after the accident estimated P6's pre-morbid cognitive functioning as low average to average. His performance on a measure of auditory attention was in the borderline to average range. When the complexity of the tasks increased his performance was in the extremely low range, as were his scores on tasks of visual attention. His

[15] Although instructed not to use other strategies during the treatment phases, P5 used her whiteboard during B2.

information processing speed, learning curve and retention of verbally presented information, cued recall, and visual spatial memory were in the extremely low range. His memory for narrative information as well as for lists of semantically unrelated words were all in the borderline range, suggesting difficulties with initial auditory span and working memory capacity. His abstract reasoning ability was in the low average range for structured tasks. His results were consistent with diffuse axonal damage, including slowed processing speed, limited attentional capacity, memory impairment and executive dysfunction.

Other difficulties were behavioral deregulation and limited insight into his difficulties. He relied on routines, visual aids, and others to remind him of daily activities. He owned a mobile phone and home computer, and had access to the internet from home. He did not own a pager. He completed high school up to 4th form (eight years of formal education).

Memory Aids Questionnaire

He used 10 strategies pre-injury and 16 strategies post-injury to assist with remembering. Strategies “always” used since his injury were notes on a wall chart, lists, asking others to remind him, mental retracing, chunking information together, and a calendar. Strategies “often” used were placing objects in unusual places, mobile phone voice calls, mobile phone text messages, and repetitive practice. He “sometimes” used a daily routine, appointment diary, organizer briefcase, and associations; and “rarely” used a weekly routine, instructions for activities and orientation of medication. Prior to his injury, P6 used a daily routine, weekly routine (“Often”), and notes on a wall chart, appointment diary, asking others to remind him, associations, chunking information together, mobile phone voice calls, mobile phone text messages, and calendar (“Rarely”). The strategies used by P6 are summarized in Table 15.

Table 15
Strategies used to assist with remembering – P6

Strategy	Use pre-injury	Use post injury	Usefulness post injury*
Notes on a wall chart	Rarely	Always	Not rated
Lists	Never	Always	Not rated
Asking others to remind me	Rarely	Always	Not rated
Mental retracing	Never	Always	Not rated
Chunking information together	Rarely	Always	Not rated
Calendar	Rarely	Always	Not rated
Mobile phone voice calls	Rarely	Often	Not rated
Mobile phone text messages	Rarely	Often	Not rated
Place objects in unusual places	Never	Often	Not rated
Repetitive practice	Never	Often	Not rated
Daily routine	Often	Sometimes	Not rated
Appointment diary	Rarely	Sometimes	Not rated
Organizer briefcase	Never	Sometimes	Not rated
Associations	Never	Sometimes	Not rated
Weekly routine	Often	Rarely	Not rated
Orientation of medication	Never	Rarely	Not rated
Instructions for activities	Never	Rarely	Not rated

* Data for P6 was collected by a research assistant. The missing data was erroneously omitted.

Patient Competency Rating Scale

Compared to ratings by his caregiver, P6 overestimated his abilities in the areas of everyday functioning, memory, and emotional functioning, and underestimated his interpersonal skills. The average point difference between self and caregiver ratings was 15 (10%).

Shapiro Control Inventory

He reported an overall sense of control below that typically found with healthy people, which indicated a lower level of belief that he had the resources to achieve and maintain control in his life. Perceptions he had about lacking or losing control could have been sufficient to restrict his thinking and behaviour relative to control issues. His responses suggested that he has a lower level of self-control and self-efficacy than that of healthy normals. P6 experienced his sense of control as coming from his own efforts to a lesser extent than that of the normative group. However, control coming from others in his life was comparable to or higher than that of healthy normals. He may have felt too reliant on others.

Baseline (A1)

He had nine tasks scheduled for each day during the baseline phase. These were: Get out of bed; Have breakfast; Make bed; Carry your phone; Put load of washing on; Hang out washing; Tidy up after self before bed; Go to bed; and Run errands around town. These were repeated each day for 20 days, adding to 180 activities over a three week period. Ninety seven of these activities were not completed. It was unclear whether some of these activities were not done because he had forgotten or were cancelled or completed by someone else. Of the remaining 83 activities he remembered 15 (18%) activities independently, used his daily routine seven times (9%), had 18 (22%) reminders form others, remembered following event-based prompt, such as hearing the washing machine make a noise, or going to bed when feeling tired, 43 times (52%).

Treatment Phase One (B1)

He had the same tasks scheduled daily as during the previous phases, which translated into 135 activities over 15 days[16]. Of the 135 activities, 100 were not completed due to changes in his schedule, being too tired to complete the tasks and others completing the tasks. For the remaining 35 activities, he remembered

[16] Possible explanations of differences in the length of time during the data collection phases include P6 not having understood instructions; non-compliance; or P6 having forgotten to complete the data recording forms. Data was collected by a research assistant.

11 (31%) activities with the use of his phone, used his routine 8 (23%) times, had 2 (6%) reminders from others, remembered independently 9 (26%) times, and used event-based cues 5 (14%) times.

Return to Baseline Phase (A2)

The same nine tasks were used as during the treatment phase. These were: Get out of bed; Have breakfast; Make bed; Carry your phone; Put load of washing on; Hang out washing; Run errands around town; Tidy up after self before bed; and Go to bed. These were repeated each day for 18 days, adding to 180 activities over a three week period. Ninety seven of these activities were not completed. It was unclear whether some of these activities were not done because he had forgotten or again whether some were cancelled or completed by someone else. Of the remaining 83 activities he remembered 15 (18%) activities independently, used his daily routine 7 times (9%), had 18 (22%) reminders form others, remembered following event-based prompt, such as hearing the washing machine make a noise, or going to bed when feeling tired, 43 times (52%).

Treatment Phase Two (B2)

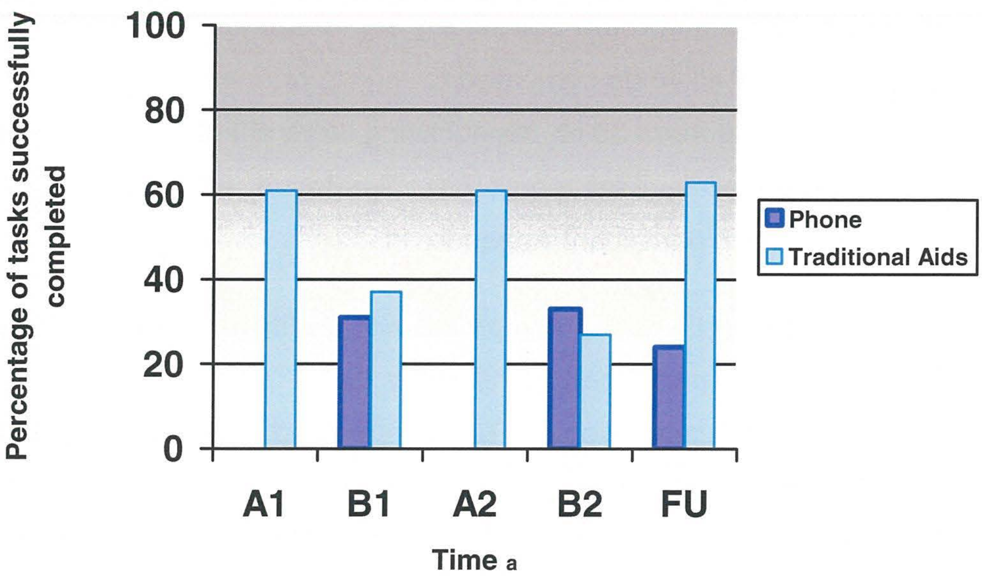
The nine tasks outlined above were repeated daily over 18 days, adding to 162 activities. One hundred and eleven of the activities were not completed for various reasons including changes to the planned schedule, his wife completing the tasks, and being too tired to complete the activities or not wanting to do them. Of the remaining 51 activities, he remembered 15 (29%) without the use of any reminders, had 3 (6%) reminders from others, remembered following event-based prompts 14 (27%) times, used his routine twice, and used the phone 17 (33%) times.

Follow-up Phase (FU)

P6 had nine tasks each day over 11 days. Of the total of 99 tasks he did not complete 50 activities, following changes in his schedule and not feeling like doing these. He remembered to do the remaining 49 activities using his phone 12 (24%)

times, event based cues 18 (37%) times, one reminder from others (2%), his routine 13 times (26%), independently remembered on 4 occasions (8%), and forgot once (2%). His results are presented in Figure 9.

P6 presented with poor insight and self-efficacy. He demonstrated moderate ability to complete activities at baseline, often then only with caregiver prompts. He used event-based prompts effectively, but only for habitual tasks. He continued to rely on event-based prompts and reminders from others while using the phone, but performed worse during the treatment phases, than at baseline.



[a] Data points without both bars indicate that that one or both types of aids were not used at all.

Figure 9. Percentage of tasks successfully completed using the phone vs. traditional aids (excluding reminders from others) - P6

General Results

Question 1: Does the use a mobile phone reminder scheduling programme improve everyday memory functioning?

This question was evaluated along two parameters: whether there were improvements in everyday memory functioning using the phone versus using no aids, and using the phone versus using traditional memory aids and strategies. Paired samples t-tests were conducted to evaluate the impact of the intervention (using a reminder scheduling programme on a mobile phone; Papyrus) on the number of tasks remembered by the participant.

All six participants showed statistically significant improvements in the number of tasks remembered when compared to relying on memory alone, with Eta Squared statistics ranging from .35 to .99 indicating large effect sizes. Differences between scores at Baseline, Treatment (A1), Treatment (B2) and Follow-up (FU) are reported for each participant Appendix 11.

When comparing the use of the phone with traditional memory aids and strategies, five participants performed significantly better while using the phone and one performed significantly worse. These remained statistically significant for four of the five participants who performed better and for the one participant who performed worse at one-month follow-up. Effect sizes remained large with Eta Squared ranging from .75 to .99. These results are presented in Appendix 11.

Question 2: Does the efficacy of a reminder scheduling programme on a mobile phone improve as a function of pre-injury familiarity with mobile phones?

Five of the six participants were familiar with the use of mobile phones before their injuries. The participant (P2) who did not use a mobile phone prior to his injury was familiar with mobile phones before the commencement of this study. One participant (P3) performed worse with the use of the phone than with the use of traditional aids, despite pre-injury familiarity with mobile phones.

Question 3: Does the efficacy of a reminder scheduling programme on a mobile phone improve as a function of self-efficacy as measured on the Shapiro Control Inventory?

Differences in level of self-efficacy did not impact on the usefulness of a reminder scheduling programme on a mobile phone for the six participants, from baseline to follow-up. Of the participants with a below average level of self-efficacy, one (P2) was not available for follow-up data collection, one (P1) made statistically significant improvements [paired samples t-test showed improvements from time A1 ($\underline{M}$=7.3, $\underline{SD}$=.95) and time FU ($\underline{M}$=10, $\underline{SD}$=1.1, $\underline{t}(9)=5.22$, $\underline{p}=<.01$, eta=.75)] one (P6) statistically declined from time A1 ($\underline{M}$=7.9, $\underline{SD}$=.32) and time FU ($\underline{M}$=2.4, $\underline{SD}$=.52, $\underline{t}(9)=24.6$, $\underline{p}=<.005$, eta=.98)] whilst using Papyrus. Level of self-efficacy was in the average range for the remaining three participants, and they made statistically significant ($\underline{p}=<.005$) improvements in everyday functioning from baseline to follow-up with large effect sizes.

Question 4: Does the efficacy of a reminder scheduling programme on a mobile phone improve as a function of insight into difficulties as measured on the Patient Competency Rating Scale?

Of the six participants, two (P2 and P6) had low levels of insight into their difficulties, and four a high level of insight. P6's scores showed declines from Baseline ($\underline{M}$=7.9, $\underline{SD}$=.32) to Follow-up ($\underline{M}$=2.4, $\underline{SD}$=.52, $\underline{t}$ (9) =24.6, $\underline{p}=<.005$, eta=.98), and P2 was not available for follow-up data collection. The remaining four participants made statistically significant improvements in everyday memory functioning ($\underline{p}=<.005$) with large effect sizes.

Question 5: Do participants who have predominant encoding difficulties show greater improvements in everyday memory functioning whilst using a reminder scheduling programme on a mobile phone improve, than participants who have predominant retrieval difficulties?

One participant (P1) showed predominantly encoding difficulties, two (P3 and P4) predominantly retrieval difficulties, and three (P2, P5, and P6) both encoding and retrieval difficulties. Participants benefited from the use of Papyrus (beyond relying on memory alone) regardless of the type of memory difficulties displayed.

DISCUSSION

The case studies presented above describe clients with diverse demographic characteristics with regard to those believed to affect the effective use of cognitive prostheses.

All six participants reported that they remembered significantly more EM tasks while using a reminder scheduling programme on a mobile phone (Papyrus), rather than when relying on memory alone. However, when comparing the use of Papyrus with traditional aids P6 showed significantly poorer performance while using the phone and P4 performed marginally better. A large predictor to the successful use of Papyrus, as with other memory aids, appears to be insight and motivation. This holds true over and above injury severity, time since injury, and specific cognitive deficits. For example, P6's relatively poorer results can be explained by the fact that he stopped using the mobile phone during the initial stages of the study. He removed the phone's SIM-card and placed it in his old phone, which he then used only to make and receive phone-calls and text messages. He also completed the data collections forms retrospectively on a number of occasions. The actions can be explained by a poorer level of insight into his difficulties than the other participants, uncertainty as how to use the phone and software (training was conducted by a research assistant), or particular deficits in executive functioning. His tasks were exactly the same daily for the course of the study, whereas tasks for the other five participants had some small variations. For example, obsolete tasks were deleted, new tasks added, and the overall number of tasks increased or decreased to suit the particular requirements of the participants. This may have translated into a higher level of face validity and motivation for them to continue with the study. P6's wife completed a number of tasks for him such as making the bed, also decreasing his need to remember tasks independently. A large number of tasks were cancelled frequently. Although P2's results showed large effect sizes (.97 and .98) from baseline to treatment phase 1 and baseline to treatment phase 2, his the number of tasks decreased to only 4 per day, inflating his results.

Four participants (P1, P3, P4, P5) reported that they increasingly remembered habitual tasks before the phone provided a prompt during the treatment phases of the study, but that these occasions decayed during the return to baseline phase. This may explain P1's smaller effect sizes during experimental phase two, as he remembered habitual tasks before the phone alarm sounded. This is an interesting finding, which may suggest a restorative component to EM for some tasks (i.e. habitual tasks), or more likely that salient content-free cues provided during habitual tasks orient the individual to the task at hand, supporting attention rather than EM per se. Another possible explanation is that they may have encoded a specific set of tasks without any generalized improvement in EM.

Overall, the use of the mobile phone and Papyrus was more efficacious than memory alone for all six participants and better than traditional memory aids for five of these six participants. While these results are encouraging, they do not reflect the effort and resource involved in training and motivating people to use the device, nor do they provide an account of other difficulties encountered in the study, many of which people with TBI (particularly those with executive deficits) may found very difficult to overcome without considerable support.

Evidence from this study regarding the impact of pre-injury familiarity with mobile phones is inconclusive. However, it makes sense to building on pre-injury skills, particularly those that are not as vulnerable to brain injury (i.e. procedural memory). The present research attempted to incorporate an operational definition of compensatory behaviour into the design of the study, including adapting a pre-existing behaviour or skill to assist with compensation of function (Simmons-Mackie & Damico, 1997).

The results on the impact of self-efficacy were mixed. Of the participants with a below average level of self-efficacy, one (P2) was not available for follow-up data collection, one (P1) made improvements and one (P6) declined in everyday functioning (number of tasks successfully remembered) whilst using a reminder scheduling programme on a mobile phone. P1 displayed a lower level of self-efficacy and a higher need for control than the other participants. He also qualitatively appeared very motivated to use Papyrus. However, four of the other participants showed a greater increases (larger effect sizes) in EM functioning. P1's level of EM functioning was much higher than that of the other participants leaving less room for improvement, which could explain this finding. Although it appears as if level of self-efficacy alone is unrelated to greater in improvements in EM, the construct of control is complex. An investigation of the impact of the sub-domains of control (i.e. self-efficacy, need for control, and agency of control) may be more useful in evaluating what and how people use resources available to them.

Earlier research on insight is more conclusive (e.g. Kim et al. 1999). People with EM impairment may lack an understanding of what actions may be necessary to mitigate their memory problems. They may also have an altered sense of knowing, or impairment in knowing how accurate their knowledge is, as well as how likely they are to accurately recognise what they know (Sohlberg & Mateer, 2001), or indeed the very need for rehabilitation. Lack of insight into the memory disorder is a often noted difficulty in TBI rehabilitation (Kim et al., 1999). As outlined earlier, awareness of personal strengths and weakness, including memory functioning, impacts on behaviour, including understanding the need for and committing to rehabilitation efforts. Lack of self-awareness poses a challenge to rehabilitation efforts. It is also associated with poor self-monitoring and poor behavioural self-regulation (Flemming, Strong, & Ashton, 1996).

Qualitatively, P2 and P6 displayed the greatest difficulties with learning how to use the phone, applying the use of the phone, and completing the data collection forms. For P2 the training phase was repeated three times, baseline data collection completed twice, and the number of activities to remember reduced. He completed the data collection forms retrospectively on one occasion, was unavailable for appointments six times, and moved before follow-up data collection could be collected. Although he reported that he remembered the activities, he rarely completed the tasks required. Attempts to increase his awareness of his difficulties were made during an admission to a specialized brain injury rehabilitation facility. Unfortunately this, as well as repeated attempts by an occupational therapist to provide useful strategies to compensate for his cognitive difficulties, was unsuccessful. One further participant (P7) withdrew from the study because she insisted that she did not need any assistance with memory. Her level of insight was severely impaired. These results suggest that insight into difficulties following TBI is related to the effective use of mobile phones to assist with EM functioning. These results support the notion that deficits in metamemory and memory self-efficacy impact on behaviour. People with EM impairment may lack an understanding of what actions may be necessary to mitigate their memory problems. These participants may have overestimated their cognitive, social and emotional functioning, reducing their motivation and effort to engage in rehabilitative efforts (Sherer, Hart, & Nick, 2002).

Moderate to severe TBI results in severe and persistent memory impairment, which is partially due to inefficient encoding strategies. This occurs in the absence of memory consolidation deficits (Hart, 1994). Permanent attention, memory, and planning deficits are expected in severe TBI, and functional and vocational rehabilitation is compromised in this group (Asikainen, 2001). The present research theorized that people with encoding difficulties would perform better while using Papyrus. However, participants benefited from the use of Papyrus regardless of the type of memory difficulties displayed.

The outcomes of the study were also evaluated along the following three dimensions: the generalizability and durability of behavioural changes in the person's natural environment; the treatment effectiveness in terms of costs and benefits; and the significance of the treatment. This entails evaluating both clinical significance (the amount of change and the importance of the change in the person's life) and the social validity (the utility and adaptiveness of behavioural change for the person's everyday functioning) of the treatment.

The generalizability and durability of behavioural changes in the person's natural environment

The training and implementation of the treatment was conducted in the person's natural environment, focussing on real life difficulties with every-day remembering. This reduced the need for the treatment to generalize into the natural environment. The durability of the treatment was not evaluated beyond one-month. However, qualitative reports from participants indicated that they planned to continue the use of the phone to assist with remembering.

The treatment effectiveness in terms of costs and benefits

The recommended retail price of the phones was NZ$600. Papyrus costs approximately NZ$30. Other costs involved included between 4 and 16 hours of training, suitably conducted by rehabilitation professionals. The costs in terms of lost function, the ability to contribute to family and community, and the financial and emotional strain on caregivers seems certain to far outweigh the relatively small cost of purchasing the system, and providing training to use the system. However, ongoing support for other difficulties, such as organizational skills, problem-solving skills, and emotional functioning would still be needed.

The significance of the treatment:

Clinical significance and social validity

Five of the six participants reported satisfaction with the phone in assisting with memory difficulties. One reported that he used the phone to make shopping lists and the MP3 player on the phone while shopping. He previously became very confused and distressed while shopping, both because he forgot what to buy and due to the noise in shops. He also returned to work part-time, assisting others with cognitive and physical disabilities. He reported that he consistently planned his days, entered and updated scheduled activities on his home computer, which were then transferred to his phone. Two other participants moved from their parents homes back to living independently. One participant successfully adapted the mobile phone and home computer software utilizing his particular strengths, such as his intact executive functioning skills and pre-injury familiarity with technology. The use of Papyrus increased EM functioning and independent living skills for five participants. They reported that the use of the phone made a valuable contribution to achieving a higher level of independence and that they would continue using the phone long term. One participant did not find the phone useful beyond traditional aids.

In summary, client-led strategies that build on pre-learnt skills such as the use of mobile phones can enhance functional outcomes even for those with severe TBI. It is clear however that facilitating the successful use of electronic cognitive aids requires close attention to each client's specific strengths and weaknesses. These include specific pre-morbid skills, use of and familiarity with technology, and level of insight into their difficulties.

Difficulties encountered in the course of the research

Research with people who have suffered a brain injury poses a number of challenges. Emotional and psychological adjustment following a brain injury impacts on recovery outcomes. Acceptance of and emotional responses to changes in cognitive functioning and personality impact greatly on people and their families, and pose a particular challenge to cognitive rehabilitation (Raskin, 2000a). In addition to problems with technology, a range of other difficulties arose in the course of the present study.

Technological difficulties were experienced on at least two occasions for each phone, resulting in disruptions and delays with the study. These included a face-cover of one phone loosening and software problems for all six phones, requiring frequent instalments of software updates, and repairs.

The nature of the study (i.e. EM and Executive Functioning deficits) resulted in some challenges. These included participants forgetting to complete the data recording forms, losing the phones, and poor negotiating problem-solving with the phones. For example, P2 lost his phone during the return to baseline phase, though he found it before the next treatment phase. Another participant left his phone on the roof of his car and drove off, after he concluded with the study. The phone required minor repairs, but he struggled to understand what was needed, the cost of repairs, and how to go about arranging for the phone to be repaired. This was arranged by the researcher after an incident when he became verbally abusive towards staff at the phone dealership.

P2 found it very difficult to complete the written work required for data collection, and avoided the researcher, but wanted to keep the phone. It is believed that he purposefully left his home when he knew an appointment was arranged, resulting in numerous trips both to his rural residence and later to the community-based rehabilitation facility in Auckland. His mother and Occupational Therapist reported that he used this strategy often to avoid commitments, such as appointments. His mother reported that he used the phone effectively to assist with remembering things that he had chosen to remember, such as meeting up with friends. He did not use the phone beyond the study to assist with other EM tasks, such as self-cares and housework tasks.

P1 initially received considerable resistance from his spouse, who served as his main source of support with remembering tasks. She feared that he would become dependent on the phone and less dependent on her. Her concerns were alleviated as the study progressed and she adjusted to changes in her role definition.

Emotional, physical and personal circumstances caused concern. P1 experienced an amnestic fugue for a few days during the study, requiring hospitalization. He also amputated part of his finger while fixing fences. Another participant made a suicide attempt, unrelated to the study, requiring hospitalization, while another moved frequently due to drug and alcohol use at the community-based rehabilitation facility where he resided. This highlights the nature of working with and conducting research with a TBI population. While the study focused on one component of cognitive rehabilitation, work occurs alongside the whole person within their matrix of cognitive strengths and difficulties, their emotional and psychological functioning, and their relationships, communities, and environments.

CHAPTER SIX: GENERAL CONCLUSIONS

Core Findings of this Research

At the outset of the study, the use of mobile phones in this way appeared very promising. As discussed in Chapter 3, both prospective memory and retrospective memory deficits impact on the ability to remember to remember, and what to remember. The use of mobile phones in the present research targeted both prospective memory and retrospective memory, by providing a salient cue that there is a planned task, and exactly what the task is. Mobile phones were used as they have the potential to compensate for deficits at each phase of EM. Phases one to three involve prospective memory, and phase four requires retrospective memory (Kliegel et al. 2004). Mobile phones compensated for phase one deficits by assisting with intention formation and encoding problems, by planning tasks and entering these (including all relevant information such as timing of intended actions) directly into the software on the phone. Phase two, the intention retention phase, deficits were overcome by the phone storing the needed information indefinitely and guarding against interference or from information extinguishing. Phase three, or the intention reinstatement phase, begins once the intended time or context for the intended action arises. Event-based cues were converted to time-based cues for the purpose of the study and salient auditory cues were provided at the planned time, limiting the need for inhibition of other ongoing activities. The fourth phase of prospective memory processing proposed by Kliegel et al. (2004) is the intention execution phase, which requires the initiative to carryout the action as intended.

Retrospective memory deficits, such as forgetting the planned actions required to execute the intention were overcome by the phone providing the content of the intention. However, receiving a cue and the content of the intention did not equate to all participants actually performing the intended task. People may also find it difficult to return to complete an intended task, once interrupted. Thöne-Otto and Walther (2003) suggested a further phase, which involves evaluation of the recall situation, which may not be conducive to executing the task, and delaying tasks if necessary. Although tasks on the phone could be delayed in five minute increments, participants with executive functioning deficits found it particularly difficult to negotiate this phase, both in terms of monitoring the recall situation and in deciding to re-enter the particular message to occur at a more suitable time, rather than continuously delaying a message.

Although the phones worked very well for four participants, introducing complicated technology to people with cognitive difficulties proved very challenging. Expectations of what the phones would contribute to recovery and improved quality to their lives exceeded reality. This highlights that devices developed to compensate for a particular lost function contributes in a meaningful way to rehabilitation as a whole, but only for some people and with limitations. For people who suffered moderate to severe brain injury, ongoing support with EM functioning, and other cognitive, behavioural and emotional deficits will remain a necessity.

Research Implications

Study One of this research supported the findings of earlier research that people benefit from using multiple strategies to assist with remembering (Evans et al., 2003; Wilson & Watson, 1996). However, Study Two provided evidence that the use of reminder scheduling software on a mobile phone is more effective than traditional aids, at least in some cases. Implications for rehabilitation include either training people to use a wide range of tools, or to focus more on intensive training in the use of EMAs.

TBI occurs most frequently in the younger population. Evans et al. (2003) report that the particular type of memory aid used is influenced by the premorbid use of similar aids. Furthermore, training in the use of electronic aids can be enhanced if the particular type of technology is already familiar to a client (Wright et al., 2001) and if therapists themselves are familiar with the technology (Hart, O'Neil-Pirozzi, & Morita, 2003). This study found that EMAs and in particular mobile phone text messages, mobile phone voice calls, and mobile phone calendar function, are considered to be more effective than non-EMAs. Rehabilitation efforts, particularly in the younger population, need to incorporate the use of EMAs already familiar to clients.

A range of factors that limit the use of EMAs have been noted, including the need for training in the use of the device (Kapur et al., 2004), limitations of use due to visual deficits, poor manual dexterity, or expressive speech impairment (van den Broek et al., 2000), and lack of insight into the memory disorder (Kim et al., 1999). However, these difficulties are not limited to EMAs. Other aids, including wall charts, lists and diaries often used in rehabilitation efforts, require intact visual, language, attentional, and executive functioning. The additional demands placed on rehabilitation teams such as technical expertise (Kirsch, Shenton, Spirl, et al., 2004) is partly controlled by using a device, such as a mobile phone, that is already familiar to most rehabilitation professionals. This research showed that the cost of EMAs can be limited by using or adapting inexpensive and commercially available technology. Other difficulties encountered in this study, including participants losing phones and phones breaking down continue to pose difficulties. Furthermore, the use of mobile phones does not compensate for other cognitive and emotional difficulties.

Lack of insight into the memory disorder is an often cited difficulty in TBI rehabilitation (Kim et al., 1999). The results from the present study add to earlier research in confirming the importance of metamemory in TBI rehabilitation, as well as for the theoretical conceptualization of EM to include metamemory.

The present research attempted to incorporate an operational definition of compensatory behaviour into the design of the study, including adapting a pre-existing behaviour or skill to assist with compensation of function (Simmons-Mackie & Damico, 1997). The aim of rehabilitation is to enhance the quality of life for injured people by increasing functional independence. Wilson (2002a) advocates a goal planning approach to rehabilitation, in which memory impaired clients, their families, and rehabilitation staff negotiate treatment goals and strategies. It is often overlooked in research that clients must buy into rehabilitation strategies for these efforts to translate into improvements in everyday functioning. Client-led strategies that build on pre-learnt skills or utilize techniques such as errorless learning can enhance functional outcomes even for those with severe TBI. It is clear that the successful use of electronic cognitive aids requires close attention to each client's specific strengths and weaknesses. These include specific pre-morbid skills, insight, emotional and personal resources, and use of and familiarity with technology. The rate at which technology is developing, and the need for rehabilitation professionals to remain informed about the possible benefits of these technological advances, necessitates additional training, support, and resources for professionals.

Limitations of this Research

Limitations to Study One include the small sample size, which reduced statistical power and prevented hypothesis testing through statistical analyses. An opportunistic sample was used, with most participants drawn from people who attended support groups. Participants were predominantly in the 40+ age range, and may have had higher levels of insight than those not attending support group meetings. The control group was not independent from the TBI group, which may have impacted on the type and number of memory aids used in the shared environment of research dyads. The results from Study One may not generalize to either a wider TBI population or the general population, particularly to those people who choose not to attend support groups or who are younger than 40. As with all self-report measures, the use of a survey and self-observation techniques are vulnerable to bias. This holds particularly true for a memory-impaired population, particularly when asking people to remember what aids they've used in the past, and which aids they have used that day to complete tasks.

In Study Two the limitations of the use of Papyrus with this population, which were identified before the outset of this study, included the need for intact verbal and visual skills, and that the software does not provide feedback on task completion or have the capability to monitor the completion of critical tasks, such as taking medication, and automatically contacting an assigned caregiver if a critical task has not been completed. Future software development for this population could incorporate these functions.

The difficulties outlined above underscored the need to focus on developing an affordable reliable, easy to use electronic aid that would be available to a wide range of people with brain injury.

Although randomized controlled trials allow for rigorous statistical analysis, increasing the validity of the findings, it was beyond the scope of this research. The exploratory nature of the study and the design employed prevented predictions about the generalizability of the treatment to the larger population of people with traumatic brain injury.

Though participants were responsible for the planning and organizing of tasks, the planning phase of EM was not formally examined. Theoretically, a marker for future events is created during the planning phase (Shallice & Burgess, 1991). For example, attentional demands increased during the planning and encoding phase of the people' schedules, and while entering these onto a novel EMA. This may have supported encoding and retrieval abilities, accounting for the increase in independent EM recall (before the alarm sounded) for some tasks. Decay in EM recall during the return to baseline phases may be due to the reduced demands on attentional resources during encoding, while using traditional aids.

Errorless learning techniques were used while training participants to use the phones. However, research within the naturalistic paradigm prevented control for other forms of learning, such as repetitive practice and trial and error learning, in between training sessions. Thus, no conclusions with regard to errorless learning are offered by this research.

Suggestions for Future Research

Future research and development possibilities, resulting from this research, include extending Papyrus, or a similar programme, into a web-based system; incorporating a navigation system; or utilizing it with the general population as a 'personal assistant'. New technology, such as "Angel" offered by Vodafone, using a message recording service can be incorporated for easy programming of schedules. "Angel" requires individuals to phone a free-phone number and leaving a voice message detailing the reminder required (including the content, time and date of the event, and time and date of the reminder) on an answer phone. Messages are collected and entered into a centralized computer, from where it is sent to a mobile phone at the correct time and date. The service was available at a monthly cost.

A randomized clinical trial could be conducted in order to improve the empirical validity of the research. Outcome studies could compare the use of commercially available and customized programmes, and traditional aids. Further investigation into variables that predict the successful use of EMAs is warranted. The role of increased demands on attentional resources during task identification and programming on EM performance requires further investigation, as do training techniques such as errorless learning and vanishing cues, when applied to learning the use of EMAs. It would be informative to evaluate the views of rehabilitation professionals with regard to the usefulness of, and their experience with technology in cognitive rehabilitation, and to identify barriers to the use of EMAs in rehabilitation.

Cognitive rehabilitation aims to ameliorate the consequences of cognitive deficits facilitated by an understanding of, and coming to terms with the deficits. Rehabilitation of cognitive deficits such as memory serves to enhance the quality of life for injured people and lessen the burden of their family members and support services (McCourt, 2002). The goal of increasing functional independence is at the core of cognitive rehabilitation. The use of mobile phones as cognitive prostheses has the potential to be customized and simplified to meet the particular needs of various populations as well as individual needs. Furthermore, they can be utilized to compensate for different deficits. However, careful consideration is necessary to overcome their limitations, including population variables such as cognitive strengths and weaknesses, lack of insight, motivation, emotional functioning, and personal support; technological variables including ongoing changes and advances in available technology; and resource variables including cost and the need for rehabilitation professionals to become aware of and familiar with the devices.

REFERENCES

Alm, N., Astell, A., Ellis, M., Dye, R., Gowans, G., & Campbell, J. (2004). A cognitive prosthesis and communication support for people with dementia. *Neuropsychological Rehabilitation, 14*(1-2), 117-134.

Asikainen, I. (2001). *Long-term functional and vocational outcome of patients with traumatic brain injury.* Unpublished Dissertation, University of Helsinki, Helsinki, Finland.

Baddeley, A. D. (1995). The psychology of memory. In A. D. Baddeley, B. A. Wilson & F. N. Watts (Eds.), *Handbook of memory disorders.* New York: Wiley.

Barnfield, T. V., & Leathem, J. M. (1998). Incidence and outcomes of traumatic brain injury and substance abuse in a New Zealand prison population. *Brain Injury,* 12(6), 455-466.

Burgess, P. W. (2000). Strategy application disorder: the role of the frontal lobes in human multitasking. *Psychological Research, 63*, 279-288.

Burgess, P. W., Quayle, A., & Frith, C. D. (2001). Brain regions involved in prospective memory as determined by positron emission tomography. *Neuropsychologia, 39*, 545-555.

Burgess, P. W., Veitch, C., De Lacy Costello, A., & Shallice, T. (2000). The cognitive and neuroanatomical correlates of multitasking. *Neuropsychologia, 38*, 848-863.

Caine, D., & Watson, J. D. G. (2000). Neuropsychological and neuropathological sequelae of cerebral anoxia: A critical review. *Journal of the International Neuropsychological Society, 6*, 86-99.

Clare, L., Wilson, B. A., Carter, G., Roth, I., & Hodges, J. R. (2002). Relearning face-name associations and early Alzheimer's Disease. *Neuropsychology, 16*(4), 538-547.

Einstein, G. O., & McDaniel, M. A. (1990). Normal aging and prospective memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 16*, 717-726.

Einstein, G. O., McDaniel, M. A., Smith, R. E., & Shaw, P. (1997). Aging and prospective memory: The influence of increased task demands at encoding and retrieval. *Psychology and Aging, 12*(3), 479-485.

Ellis, J., & Kvavilashvili, L. (2000). Prospective memory in 2000: Past, present, and future directions. *Applied Cognitive Psychology, 14*(7), 1-9.

Evans, J. J., Wilson, B. A., Needham, P., & Brentnall, S. (2003). Who makes good use of memory aids? Results of a survey of people with acquired brain injury. *Journal of the International Neuropsychological Society, 9*, 925-935.

Flemming, K. L., Baguley, I. J., & Green, A. M. (2004). Effect of diffuse axonal injury on speed of information processing following severe traumatic brain injury. *Neuropsychology,* 18 (3), 564-571.

Fork, M., Bartels, C., Ebert, A. D., Grubich, C., Synowitz, H., & Wallesch, C. (2005). Neuropsychological sequelae of diffuse traumatic brain injury. *Brain Injury,* 19 (2), 101-108.

Fraser, S., Glass, J. N., & Leathem, J. M. (1999). Everyday memory in an elderly New Zealand population: Performance on the Rivermead Behavioural Memory Test. *New Zealand Journal of Psychology, 28*(2), 118-129.

Fujii, D. E. (1996). Kolb's learning styles and potential cognitive remediation of brain-injured people: An exploratory factor analysis study. *Professional Psychology: Research and Practice, 27*(3), 266-271.

Gilandas, A., Touyz, S., Beumont, P. J. V., & Greenberg, H. P. (1984). *Handbook of neuropsychological assessment.* Sydney: Grune & Stratton.

Godfrey, H. P. D., & Knight, R. G. (1985). Cognitive rehabilitation of memory functioning in amnesiac alcoholics. *Journal of Consulting and Clinical Psychology, 53*(4), 555-557.

Graf, P., & Uttl, B. (2001). Prospective memory: A new focus for research. *Consciousness and Cognition, 10*(4), 437-450.

Graham, I. D. (1995). Neuropathology of head injury. In P. D. Nussbaum (Ed.), *Handbook of neuropsychology and aging* (pp. 43 - 59). New York: McGraw.

Hannon, R. (1995). Effects of brain injury and age on prospective memory. *Rehabilitation Psychology, 40*(4), 289-298.

Hart, T., Hawkey, K., & Whyte, J. (2002). Use of a portable voice organizer to remember therapy goals in traumatic brain injury rehabilitation: A within-subjects trial. *Journal of Head Trauma Rehabilitation, 17*(6), 556-570.

Henry, J. D., MacLeod, M. S., Phillips, L. H., & Crawford, J. R. (2004). A meta-analytic review of prospective memory and aging. *Psychology and Aging, 19*(1), 27-39.

Hopkins, R. O., Tate, D. F., Bigler, E. D. (2005). Anoxic versus traumatic brain injury: Amount of tissue loss, not etiology, alters cognitive and emotional function. *Neuropsychology,* 19 (2), 233-242.

Huppert, F. A., Johnson, T., & Nickson, J. (2000). High prevalence of prospective memory impairment in the elderly and in early-state dementia: Findings from a population-based study. *Applied Cognitive Psychology, 14*(7), 63-81.

Inglis, E. A., Szymkowiak, A., Gregor, P., Newell, A. F., Hine, N., Wilson, B. A., et al. (2004). Usable technology? Challenges in designing a memory aid with current electronic devices. *Neuropsychological Rehabilitation, 14*(1-2), 77-87.

Kalat, J. W. (1998). *Biological psychology* (6th ed.). Pacific Grove, California: Brooks/Cole.

Kapur, N., Glisky, E. L., & Wilson, B. A. (2004). Technological memory aids for people with memory deficits. *Neuropsychological Rehabilitation, 14*(1-2), 41-60.

Kapur, N. (1999). Syndromes of retrograde amnesia: A conceptual and empirical synthesis. *Psychological Bulletin,* 125 (6), 800-825.

Kertez, A., & Gold, B. T. (2003). Recovery of cognition. In K. M. Heilman & E. Valenstein (Eds.), *Clinical Neuropsychology.* Oxford: Oxford University Press.

Kesner, R. P., & Rogers, J. (2004). An analysis of independence and interactions of brain substrates that subserve multiple attributes, memory systems, and underlying processes. *Neurobiology of Learning & Memory, 82*(3), 119-215.

Kim, H. J., Burke, D. T., Dowds, M. M., & George, J. (1999). Utility of a microcomputer as an external memory aid for a memory-impaired head injury patient during in-patient rehabilitation. *Brain Injury, 13*(2), 147-150.

Kirsch, N. L., Shenton, M., & Rowan, J. (2004). A generic, 'in-house', alphanumeric paging system for prospective activity impairments after traumatic brain injury. *Brain Injury, 18*(7), 725-734.

Kit, K. A., Mateer, C. A., & Graves, R. E. (2007). The influence of memory beliefs in individuals with traumatic brain injury. *Rehabilitation Psychology,* 52(1), 25-32.

Kliegel, M., Eschen, A., & Thöne-Otto, A. I. T. (2004). Planning and realization of complex intentions in traumatic brain injury and normal aging. *Brain and Cognition, 56*, 43-54.

Kopp, U. A., & Thöne-Otto, A. I. T. (2003). Disentangling executive functions and memory processes in event-based prospective remembering after brain damage: A neuropsychological study. *International Journal of Psychology, 38*(4), 229-235.

Krans, J. F., & Chu, L. D. (2005). Epidemiology. In J. M. Silver, T. W. McAllister, & S. C. Yudofsky. *Textbook of Traumatic Brain Injury.* Washington, DC: American Psychiatric Publishing Inc.

Leathem, J. M., Murphy, L. J., & Flett, R. A. (1998). Self- and informant-ratings on the Patient Competency Rating Scale in patients with traumatic brain injury. *Journal of Clinical and Experimental Neuropsychology, 20*(5), 694-705.

Levin, C., Ilgen, M., & Moos, R. (2007). Avoidance coping strategies moderate the relationships between self-efficacy and 5-year alcohol treatment outcomes. *Psychology of Addictive Behaviours 21*(1), 108-113.

Levine, H. S., O'Donnell, V. M., & Grossman, R. G. (1979). The Galveston Orientation and Amnesia Test: A practical scale to assess cognition after head injury. *Journal of Nervous and Mental Disease, 167*, 675-684.

Leynes, P. A., Marsh, R. L., & Hick, J. L. (2003). Investigating the encoding and retrieval of intentions with event-related potentials. *Consciousness and Cognition, 12*(1), 1-18.

Lezak, M. D., Howieson, D. B., & Loring, D. W. (2004). *Neuropsychological assessment* (4th ed.). Oxford: Oxford University Press.

Lucas, J. A. (1998). Traumatic brain injury and postconcussive syndrome. In P. J. Snyder & P. D. Nussbaum (Eds.), *Clinical neuropsychology: a pocket handbook for assessment* (pp. 243-265). Washington DC: American Psychological Association.

Martin, M., Kliegel, M., & McDaniel, M. A. (2003). The involvement of executive functions in prospective memory performance of adults. *International Journal of Psychology, 38*(4), 195-206.

Mateer, C. A., & Raskin, S. A. (2000). *Neuropsychological management of mild traumatic brain injury.* New York: Oxford University Press.

McAllister, T. W. (1994). Mild traumatic brain injury and the postconcussive syndrome. In J. M. Silver, S. C. Yudosski & R. E. Hales (Eds.), *Neuropsychology of traumatic brain injury* (pp. 357-372). Washington DC: American Psychiatric Press.

McCourt, J. (2002). Rehabilitation without error. *The Psychologist, 15*(4), 240-241.

McDaniel, M. A., & Einstein, G. O. (2000). Strategic and automatic processes in prospective memory retrieval: A multiprocess framework. *Applied Cognitive Psychology, 14*(7), 127-144.

McDaniel, M. A., Glisky, E. L., & Guynn, M. J. (1999). Prospective memory: a neuropsychological study. *Neuropsychology, 13*(1), 103-110.

McDaniel, M. A., Guynn, M. J., Einstein, G. O., & Breneiser, J. (2004). Cue-focused and reflexive-associative processes in prospective memory retrieval. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 30*(3), 605-614.

Neath, I., & Surprenant, A. M. (2003). *Human memory* (2nd ed.). London: Thomson Wadsworth.

Nelson, C. A., & Luciana, M. (Eds.). (2001). *Handbook of developmental cognitive neuroscience.* Cambridge: The MIT Press.

Ownsworth, T. L., & McFarland, K. (1999). Memory remediation in long-term acquired brain injury: two approaches in diary training. *Brain Injury, 13*(8), 605-626.

Park, D. C., Hertzog, C., Kidder, D. P., Morell, R. W., & Mayhorn, C. B. (1997). Effects of age on event-based and time-based prospective memory. *Psychology and Aging, 12*, 314-327.

Quemada, J. I., Ceuspedes, J. M. M., Ezkerra, J., Balleseros, J., Ibarra, N., & Urruticoechea, I. (2003). Outcome of memory rehabilitation in traumatic brain injury assessed by neuropsychological tests and questionnaires. *Journal of Head Trauma Rehabilitation, 18*(6), 532-540.

Raskin, S. (2000a). Executive functions. In S. Raskin & C. A. Mateer (Eds.), *Neuropsychological management of mild traumatic brain injury*. New York: Oxford University Press.

Raskin, S. (2000b). Memory. In S. A. Raskin & C. A. Mateer (Eds.), *Neuropsychological management of mild traumatic brain injury*. New York: Oxford University Press.

Rendell, P. G., & Craik, F. I. M. (2000). Virtual week and actual week. *Applied Cognitive Psychology, 14*(7), 43-62.

Richardson, J. T. E. (2000). *Clinical and neuropsychological aspects of closed head injury* (2nd ed.). Hove, East Sussex: Psychology Press.

Rugg, M. D. (2002). Functional neuroimaging of memory. In A. D. Baddeley, M. D. Kopelman & B. A. Wilson (Eds.), *The handbook of memory disorders* (pp. 57-80). Chichester, West Sussex: Wiley.

Schmidt, I. W., Berg, I. J., & Deelman, B. G. (2001). Prospective memory training in older adults. *Educational Gerontology, 27*, 455-478.

Schmitter-Edgecombe, M., Fahy, J. F., Whelan, J. P., & Long, C. J. (1995). Memory remediation after severe closed head injury: Notebook training versus supportive therapy. *Journal of Consulting and Clinical Psychology, 63*(3), 484-489.

Schmitter-Edgecombe, M., & Wright, P. (2004). Event-based prospective memory following severe closed-head injury. *Neuropsychology, 18*(2), 353-361.

Shallice, T., & Burgess, P. W. (1991). Deficits in strategy application following frontal lobe damage in man. *Brain and Cognition, 114*(727-741).

Smith, E. E., & Jonides, J. (1999). Storage and executive processes in the frontal lobes. *Science, 283*(5408), 1657-1661.

Snyder, P. J., & Nussbaum, P. D. (Eds.). (2002). *Clinical Neuropsychology*. Washington, DC: American Psychological Association.

Sohlberg, M. M., & Mateer, C. A. (2001). *Cognitive rehabilitation: An integrative neuropsychological approach*. New York: The Guilford Press.

Stuss, D. T., & Levine, B. (2002). Adult clinical neuropsychology: Lessons from studies of the frontal lobes. *Annual Review Psychology, 53*, 401-433.

Tate, R. L., McDonald, S., & Lulham, J. M. (1998). Incidence of hospital-treated traumatic brain injury in an Australian community. *Australian and New Zealand Journal of Public Health, 22*, 419-423.

Teasdale, T. W., & Jennet, B. (1974). Assessment of coma and impaired consciousness. *Lancet, 2*, 81-84.

Thomsen, I. V. (1987). Late psychosocial outcome in severe blunt head trauma: review. *Brain Injury, 1*, 131-143.

Torgensen, J. K. (1996). A model of memory from an information processing perspective. In G. R. Lyon & N. A. Krasnegor (Eds.), *Attention, memory, and executive function* (pp. 157-184). Baltimore: Paul H Brookes.

Uttl, B., & Graf, P. (2001). Pro- and retrospective memory in late adulthood. *Consciousness and Cognition, 10*(4).

van den Broek, M. D., Downes, J., Johnson, Z., Dayus, B., & Hilton, N. (2000). Evaluation of an electronic memory aid in the neuropsychological rehabilitation of prospective memory deficits. *Brain Injury, 14*(5), 455-462.

Wade, T. K., & Troy, J. C. (2001). Mobile phones as a new memory aid: a preliminary investigation using case studies. *Brain Injury, 15*(4), 305-320.

Walsh, K. W. (1991). *Understanding brain damage* (2nd ed.). Edinburgh: Churchill Livingstone.

Wilson, B., Cockburn, J., Baddeley, A., & Hiorns, R. (1989). The development and validation of a test battery for detecting and monitoring everyday memory problems. *Journal of Clinical and Experimental Neuropsychology, 11*(6), 855-870.

Wilson, B. A. (2002). Memory rehabilitation. In L. R. Squire & D. L. Schacter (Eds.), *Neuropsychology of memory* (3rd ed., pp. 263 - 272). New York: Guilford.

Wilson, B. A., Emslie, H. C., Quirk, K., & Evans, J. J. (2001). Reducing everyday memory and planning problems by means of a paging system: a randomised control crossover study. *Journal of Neurology, Neurosurgery and Psychiatry, 70*(4), 477-482.

Wilson, B. A., Evans, J. J., Emslie, H., & Malinek, V. (1997). Evaluation of NeuroPage: a new memory aid. *Journal of Neurology, Neurosurgery and Psychiatry, 63*, 113-115.

Wilson, B. A., & Watson, P. C. (1996). A practical framework for understanding compensatory behaviour in people with organic memory impairment. *Memory, 4*(465-486).

Wright, P., Rogers, N., Hall, C., Wilson, B., Evans, J., Emslie, H., et al. (2001). Comparison of pocket-computer memory aids for people with brain injury. *Brain Injury, 15*(9), 787-800.

Appendix 1: Memory Aids Questionnaire

Methods People use for Assisting with Remembering **Name:** ______________

Instructions **Date:** ______________

People have many different ways of remembering things. This questionnaire asks about the methods that you use now and the methods that you have used before your injury to help with remembering. It also asks that you rate the usefulness of the methods that you use now. It is important to know something about the participants, so we request this extra information. Only grouped data will be used, and you will not be identified. Please circle the number next to the statement that best describes you.

1. Your Sex: **1** MALE **2** FEMALE

2. Your Age: ___________

3. Your Education:
   - **1** Some Secondary School — Please specify______________
   - **2** School Certificate — NCEA Level 1
   - **3** University Entry — NCEA Level 2
   - **4** Bursary / Scholarship — NCEA Level 3
   - **5** Certificates / Diplomas / Training: — Please specify ______________
   - **6** University graduate
   - **7** Some post graduate
   - **8** Masters
   - **9** Ph.D., M.D., etc.

4. Do you own a pager: **1** Yes **2** No

5. Do you own a mobile phone: **1** Yes **2** No

6. Do you own a home computer: **1** Yes **2** No

7. Do you have access to the internet: **1** Yes **2** No

   If yes: **1** Home **2** Work

8. Date of injury: ________/________/________

9. Cause of Injury:
   - **1** Motor Vehicle Accident
   - **2** Fall
   - **3** Pedestrian in Accident
   - **4** Assault
   - **5** Sport Related Injury
   - **6** Infection
   - **7** Stroke
   - **8** Other: Please Specify________

Listed below are some of the many methods that people have used to assist with remembering. Please read the following statements carefully. Indicate whether you use each strategy **to help you remember**. If you **do** use the strategy, circle the number that best describes how often you use that strategy and how useful that strategy is to help you remember. Only indicate your feeling about a strategy if you use it or have used it in the past. If you **do not** use a particular strategy **to help you remember**, please circle 1 for 'Never'. Please circle a number in each column for every question.

	Now I Use					**Now Usefulness**					**Before the Injury I Used**				
To help me remember I use a:	Never	Rarely	Sometimes	Often	Always	Never	Rarely	Sometimes	Usually	Very	Never	Rarely	Sometimes	Often	Always
10. Home Computer *For example, using your home computer to keep a diary, an activity schedule, or a 'to do' list.*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
11. Electronic Organizer or Electronic Diary *For example, using a palm pilot, personal digital assistant, or other electronic device to schedule tasks*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
12. Dictaphone or Voice Recorder *For example, recording a grocery item to buy, or a telephone number on a voice recorder.*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
13. Pager *For example, receiving a message on a pager to remind you to do a particular task.*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5

MOBILE PHONE: If you have never used a Mobile Phone to help you remember please go to Question 22

	Never	Rarely	Sometimes	Often	Always	Never	Rarely	Sometimes	Usually	Very	Never	Rarely	Sometimes	Often	Always
14. Mobile Phone- voice calls: *For example, someone calling you on your mobile phone to remind you of something*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5

To help me remember I use a:	**Now I Use**					**Now Usefulness**					**Before the Injury I Used**				
	Never	Rarely	Sometimes	Often	Always	Never	Rarely	Sometimes	Usually	Very	Never	Rarely	Sometimes	Often	Always
15. Mobile Phone-voice messages *For example, leaving a voice message on your mobile phone to remind you of something*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
16. Mobile Phone- text messages *For example, receiving a text message to remind you of something*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
17. Mobile Phone- picture messages *For example, receiving a picture message to remind you of something*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
18. Mobile Phone-video messages *For example, receiving a video message to remind you of something*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
19. Mobile Phone-e-mail messages *For example, using Microsoft Outlook to set up reminders of task that are sent to your mobile phone*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
20. Mobile Phone-alarm function *For example, setting the alarm on you mobile phone to sound at a particular time to remind you of something*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
21. Mobile Phone-calendar function *For example, making notes on your mobile phone calendar to remind you of tasks or activities*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5

To help me remember I use a:	Now I Use					Now Usefulness					Before the Injury I Used				
	Never	Rarely	Sometimes	Often	Always	Never	Rarely	Sometimes	Usually	Very	Never	Rarely	Sometimes	Often	Always
22. Daily Routine *For example, scheduling activities at the same time every day, such as getting-up at 7am, and eating at 8am.*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
23. Weekly Routine *For example, going shopping every Wednesday and visiting friends every Friday*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
24. Notes on a Wall Chart or Notice Board *For example, writing appointments down on a wall chart.*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
25. Lists *For example, grocery lists or lists of tasks for the day.*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
26. Instructions for Activities *For example placing instructions on how to use the washing machine on the laundry wall.*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
27. Appointment Diary *For example, writing an appointment with the dentist in a diary.*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
28. Pocket Phone book *For example, to help you remember phone numbers.*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
29. Organizer handbag or Briefcase *For example, keeping your keys in the same pocket in your handbag or briefcase.*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5

To help me remember I use a:	Now I Use					Now Usefulness					Before the Injury I Used				
	Never	Rarely	Sometimes	Often	Always	Never	Rarely	Sometimes	Usually	Very	Never	Rarely	Sometimes	Often	Always
30. Home Filing *For example, filing bills to be paid in due-date order.*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
31. Ask others to remind me *For example, asking your partner to remind you to do something at a particular time*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
32. Place Objects in Unusual Places *For example, leaving your handbag by the front door.*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
33. Orientation of Medication *For example, leaving your medication in your cutlery drawer to remind you to take it with your meal.*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
34. Notes in Special Places *For example, leaving a post-it note on your television to remind you of a programme you want to watch.*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
35. Alarm Clock to help me remember tasks *For example, setting an alarm to sound 10 minutes before a television programme that you want to watch*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
36. Information on a key ring *For example, writing your home phone number on a tag attached to your key ring.*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5

To help me remember I use a:	**Now I Use**					**Now Usefulness**					**Before the Injury I Used**				
	Never	Rarely	Sometimes	Often	Always	Never	Rarely	Sometimes	Usually	Very	Never	Rarely	Sometimes	Often	Always
37. Pillbox or Blister pack *For example, using a pillbox with each day having a compartment to place pills in.*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
38. Mental Retracing *For example, retracing your steps to remember where you left something.*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
39. Repetitive Practice *For example, repeatedly practicing a task until you remember how to do the task without prompts.*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
40. Associations *For example associating a name with an object to help you remember the name.*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
41. Alphabet Searching *For example, searching through the alphabet to help you remember items on your shopping list.*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
42. Visual Imagery *For example imagining the items on your shopping list placed throughout your house.*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
43. First Letter Mnemonics *For example, remembering the word "Bun" to remind you to **b**uy groceries, take a **u**niform to the drycleaners, and change your pin **n**umber on your bank card*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5

To help me remember I use a:	Now I Use					Now Usefulness					Before the Injury I Used				
	Never	Rarely	Sometimes	Often	Always	Never	Rarely	Sometimes	Usually	Very	Never	Rarely	Sometimes	Often	Always
44. Peg-Word mnemonics *Learning pegs such as one is bun, two is shoe etc and associating an item with the word "bun" and "shoe". For example, visualizing a bun-shaped handbag to remind you to take your handbag*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
45. Chunk Information together *For example, chunking grocery items in groups such as "Fruit: Apples, Bananas...Meat: Chicken, Mince" rather than remembering "Chicken, Apples, Carrots, Mince etc.*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5

Please list any other methods that you use to help you remember, and rate how useful that method is.

To help me remember I use a:	Now I Use					Now Usefulness					Before the Injury I Used				
	Never	Rarely	Sometimes	Often	Always	Never	Rarely	Sometimes	Usually	Very	Never	Rarely	Sometimes	Often	Always
46.	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5

THANK YOU VERY MUCH FOR YOUR HELP WITH THIS SURVEY

Appendix 2: Patient Competency Rating Scale – Patient form

Patient Competency Rating
(Patient's Form)

Source: Prigatano, G. P. and Others (1986). Neuropsychological Rehabilitation After Brain Injury. Baltimore: Johns Hopkins University Press.

Identifying Information

Patient's Name:

Date: ________________

Instructions

The following is a questionnaire that asks you to judge your ability to do a variety of very practical skills. Some of the questions may not apply directly to things you often do, but you are asked to complete each question as if it were something you "had to do." On each question, you should judge how easy or difficult a particular activity is for you and mark the appropriate space.

Competency Rating

1	2	3	4	5
Can't do	Very difficult to do	Can do with some difficulty	Fairly easy to do	Can do with ease

1. How much of a problem do I have in preparing my own meals?
2. How much of a problem do I have in dressing myself'?
3. How much of a problem do I have in taking care of my personal hygiene?
4. How much of a problem do I have in washing the dishes?
5. How much of a problem do I have in doing the laundry?
6. How much of a problem do I have in taking care of my finances?
7. How much of a problem do I have in keeping appointments on time?
8. How much of a problem do I have in starting conversation in a group?
9. How much of a problem do I have in staying involved in work activities even when bored or tired?

1	2	3	4	5
Can't do	Very difficult to do	Can do with some difficulty	Fairly easy to do	Can do with ease

10. How much of a problem do I have in remembering what I had for dinner last night?

11. How much of a problem do I have in remembering names of people I see often?

12. How much of a problem do I have in remembering my daily schedule?

13. How much of a problem do I have in remembering important things I must do?

14. How much of a problem would I have driving a car if I had to?

15. How much of a problem do I have in getting help when I'm confused?

16. How much of a problem do I have in adjusting to unexpected changes?

17. How much of a problem do I have in handling arguments with people I know well?

18. How much of a problem do I have in accepting criticism from other people?

19. How much of a problem do I have in controlling crying?

20. How much of a problem do I have in acting appropriately when I'm around friends?

21. How much of a problem do I have in showing affection to people?

22. How much of a problem do I have in participating in group activities?

23. How much of a problem do I have in recognizing when something I say or do has upset someone else?

24. How much of a problem do I have in scheduling daily activities?

25. How much of a problem do I have in understanding new instructions?

26. How much of a problem do I have in consistently meeting my daily responsibilities?

27. How much of a problem do I have in controlling my temper when something upsets me?

28. How much of a problem do I have in keeping from being depressed?

29. How much of a problem do I have in keeping my emotions from affecting my ability to go about the day's activities?

30. How much of a problem do I have in controlling my laughter?

Appendix 3: Patient Competency Rating Scale – Relative form

Patient Competency Rating
(Relative's Form)

Source: Prigatano, G. P. and Others (1986). Neuropsychological Rehabilitation After Brain Injury. Baltimore: Johns Hopkins University Press.

Identifying Information

Patient's Name:

Date: ____________________

Informant's relationship to patient (circle one):

1. Mother	8. Niece or nephew
2. Father	9. Cousin
3. Spouse	10. Friend
4. Child	11. In-law
5. Sibling	12. Ward attendant
6. Grandparent	13. Other ______________________
7. Aunt or uncle	

Sex of informant:

Male ________

Female _______

How well is informant acquainted with patient's behavior?

1. Hardly at all	4. Pretty well
2. Not so well	5. Very well
3. Fairly well	

Instructions

The following is a questionnaire that asks you to judge this person's ability to do a variety of very practical skills. Some of the questions may not apply directly to things they often do, but you are asked to complete each question as if it were something they "had to do." On each question, you should judge how easy or difficult a particular activity is for them and mark the appropriate space.

Competency Rating

1	2	3	4	5
Can't do	Very difficult to do	Can do with some difficulty	Fairly easy to do	Can do with ease

1. How much of a problem do they have in preparing their own meals?
2. How much of a problem do they have in dressing themselves?
3. How much of a problem do they have in taking care of their personal hygiene?
4. How much of a problem do they have in washing the dishes?
5. How much of a problem do they have in doing the laundry?
6. How much of a problem do they have in taking care of their finances?
7. How much of a problem do they have in keeping appointments on time?
8. How much of a problem do they have in starting conversation in a group?
9. How much of a problem do they have in staying involved in work activities even when bored or tired?
10. How much of a problem do they have in remembering what they had for dinner last night?
11. How much of a problem do they have in remembering names of people they see often?
12. How much of a problem do they have in remembering their daily schedule?
13. How much of a problem do they have in remembering important things they must do?
14. How much of a problem would they have driving a car if they had to?
15. How much of a problem do they have in getting help when they are confused?
16. How much of a problem do they have in adjusting to unexpected changes?
17. How much of a problem do they have in handling arguments with people they know well?
18. How much of a problem do they have in accepting criticism from other people?

1	2	3	4	5
Can't do	Very difficult to do	Can do with some difficulty	Fairly easy to do	Can do with ease

19. How much of a problem do they have in controlling crying?

20. How much of a problem do they have in acting appropriately when they are around friends

21. How much of a problem do they have in showing affection to people?

22. How much of a problem do they have in participating in group activities?

23. How much of a problem do they have in recognizing when something they say or do has upset someone else?

24. How much of a problem do they have in scheduling daily activities?

25. How much of a problem do they have in understanding new instructions?

26. How much of a problem do they have in consistently meeting their daily responsibilities?

27. How much of a problem do they have in controlling their temper when something upsets them?

28. How much of a problem do they have in keeping from being depressed?

29. How much of a problem do they have in keeping their emotions from affecting their ability to go about the day's activities?

30. How much of a problem do they have in controlling their laughter?

Appendix 4: List of Tasks

Task	Date to complete	Start time	End time	Entered: Yes / No

Appendix 5: Data recording form

Name: ________________ **Date:** ________________

Task	Task Completed? Yes / No	Time Remembered?	Remembering Strategy Used?

Appendix 6: Training and User Manual

Training Manual

Rationale

Errorless Learning is a teaching technique that is particularly amenable to teaching new skills to people with Acquired Brain Injury. It is founded on the premise that these people have a reduced capacity to learn from mistakes. Studies have shown that people with memory difficulties learn better through Errorless Learning than from traditional trial-and-error approaches. People are prevented from making any mistakes during the teaching sessions. A skill is demonstrated, the individual repeats each sequence in a task verbally, and is then aided in performing each sequence in the task correctly until the task is completed independently. This approach is based on Behavioural Shaping principles. This means that only once the first sequence of a task is mastered, teaching of the subsequent sequences follow in order of mastery. Verbal instructions, physical prompts, demonstrations, and reference material are provided as needed to prevent errors in learning. Positive reinforcement is provided for the accurate completion of each step.

Procedures

The sequences of using the phone and related software are outlined in the sections: Getting started with your phone / Using Papyrus / Microsoft Outlook / Nokia PC Suite.

Training starts with introducing the phone to the participant, including how to turn it on and off; how to charge the battery; enter the menu and select an application; how to set the alarm; how to select the phone mode; how to make voice calls; how to write, edit, delete, send, and receive text messages; and how to add, edit and delete contacts from the address book.

Papyrus is introduced and the participant is taught on how to open the application; use Views; use Go- to- Date, Entering and configuring a new meeting, editing a meeting, deleting a meeting, and closing the application.

Microsoft Outlook is introduced (only for participants with a personal PC). The participant is taught on how to open the application, add, edit and delete an appointment, and synchronize Microsoft Outlook and the phone.

Nokia PC Suite is introduced; and the participants is taught how to open the application; connect the phone and the PC with the data cable; and how to synchronize the phone and PC (Only for participants with a personal PC)

Training for each task involves:

1. Instructing the participant not to guess, but to ask if they do not know what the next task sequence is or the answer to a question is.
2. Providing prompts, verbal feedback, and reinforcement.
3. Instruction on where the keys on the phone are.
4. Instruction on the function of each key on the phone
5. Asking what function each key on the phone serves
6. Instruction on how to execute each task sequence
7. Demonstrating how to execute each task sequence
8. Asking the participant to verbalize each task sequence
9. Providing support with executing each task sequence
10. The participant independently executing each task sequence, with the aid of the user manual
11. The participant independently executing each task sequence without the aid of he user manual, but with the aid of the key-ring
12. The participant independently executing each task sequence until the task is mastered

User Manual

Technical Specifications: Nokia 5500 Sport

Key Features

System:	GSM 900/1800/1900
User Interface:	Symbian Series 60 Platform
Dimensions:	107 mm x 45mm x 18mm
Weight:	103g
Standby time:	Up to 10 days
Talk time:	Up to 4.5 hours
Display:	208 x 208, 262,144 colors
Battery:	BL – 5B 860 mAh
Camera:	2 Mpx Image resolution – 1600 x 1200 max Video resolution – 176 x 144
Streaming and Video Capture:	sub-QCIF (128 x 96 pixels)
Connectivity:	Bluetooth wireless technology Infrared Data cable
Messaging:	SMS/MMS/E-mail/Instant Messaging
Audio: player	MP3 / AMP / AAC / eAAC+ / WMA, Real Player media
Memory:	64MB; supports MicroSD cards up to 1GB, USB mass storage class
Sales Package incl.:	Nokia 5500 Sport phone Nokia Compact Charger AC-3 Nokia Active Stereo Headset HS-29/AD-45 Nokia microSD Memory Card Nokia Connectivity Cable CA-53

Computer System Requirements

Windows 2000, service pack 4 or Windows XP, service pack 1 or 2, 32 or 64 bit (Home or Professional edition)

At least 200 MB of free disk space

Administration rights to the PC

One of:

- USB Connection cable (DKU-2, DKE-2 or CA-53) and compatible port on the PC
- Serial connection cable (CA-42) and a compatible port on the PC
- Infrared (IrDA) port on the PC
- Bluetooth wireless technology equipment and software

Software Installation

Nokia PC Suite

With Nokia PC Suite you can synchronize contacts, calendar, and to-do notes between your phone and a compatible PC, or a remote Internet Server. Nokia PC Suite supported applications include Microsoft Outlook 200/2002/2003; Microsoft Outlook Express (Windows Address Book); Lotus Notes 5.0/6x; and Lotus Organizer 5.0/6.0. An installation CD is provided with the phone. Place the CD in the CD-rom drive of your PC. The set-up will automatically start. Follow the on-screen instructions.

Microsoft Outlook

Insert the Microsoft Outlook CD in the CD-rom drive of your PC. The set-up will automatically start. Select Microsoft Outlook, and follow the onscreen instructions. (Microsoft Outlook has not been provided for research participants. The use of Microsoft Outlook to enter tasks was done with the researcher's personal computer where the participant did not have or use a home computer, or did not have Microsoft Outlook installed. It is an optional addition to the study as all tasks can be entered, edited and deleted directly on the phone.)

Papyrus

Papyrus software is a calendar and scheduling software package for smart phones. Papyrus can be purchased from www.sbsh.com. Once Papyrus and Nokia PC Suite is installed on your PC and Papyrus is downloaded, connect your phone and PC with the USB data cable. Click on connect. Click on Install software in PC suited, Select Papyrus, and follow the on-screen instructions on your phone. Papyrus has been pre- installed on the phones for research participants.

Getting started with your phone

Charging the battery:

Connect the charger to the wall socket. Connect the lead from the charger to the charger connector in the phone

Switch the phone on and off:

Press and hold the power key. If the phone asks for a PIN code, enter the code. If the phone asks for a lock code, enter the lock code and select OK. The factory setting for the lock code is 12345

To enter the menu functions:

Press the menu key, and scroll to the desired application.

To set the alarm:

Press the menu key, scroll to Organizer, scroll to Clock, press enter (joystick), press Options – left selection key, scroll to set alarm, enter (joystick), set the time, Enter (joystick).

To use the flashlight:

In standby mode press and hold the star key (bottom left), press and hold to turn off the flash light

To select the mode:

Press the Instant swap key to toggle among phone, music and sport modes

Press the menu key to enter the phone menu

Push the Exit key – right selection key to exit the menu and return to standby mode

Call functions

To make a call in standby mode enter the phone number, including area code and press the left call key

To answer a call press the left call key

To end a call press the right end key

To make a call from your contacts, press the left selection key (Contacts), select the contact that you want to phone, press the call key

Messaging

To retrieve a voice message, dial 707 and follow the voice prompts

To write a text message, press the left scroll-bar, type the recipients phone number in the TO: box or press options, add recipient, select recipient from your contacts list, enter, scroll down, type in message, press the left call key.

To read a message, select yes when asked if you want to view the message or Press the menu key, select Messaging, select Inbox, select the Message, Enter

Contacts

To add a contact, press Contacts – left selection key, scroll to New contact, Enter, Type in details, press Done – right selection key

To edit or delete a contact, press Contacts, select the contact that you want to edit or delete, press Options, make changes, press Done, or press Delete.

Other functions

Your phone has a vast array of available functions. For instructions on how to use these functions please refer to your Nokia 5500 operating manual, or ask the researcher.

Using Papyrus

Opening software

Open Papyrus on your phone by pushing the right **Scroll-bar**.

Alternatively, push the **Menu** button on your phone. **Scroll** to Papyrus. Push **Enter** (joystick)

Views

Select **Menu** with the left selection key

Scroll to **View** with the bottom scroll-bar

Push **Enter** (joystick)

Scroll to the view that you want (Daily, Grid, Monthly or List). The view that you are currently in is not displayed as an option in Views

Push **Enter** (joystick) or Push Select with the left selection key

Or

Toggle between views with the **right selection key**

Go to date

Select **Menu** with the left selection key

Scroll to **Go to Date** with the bottom scroll-bar

Push **Enter** (joystick)

Enter the date that you require with the keypad

Push **Enter** (joystick)

Or

Toggle to any date with the right scroll-bar (dates are displayed in the top blue toolbar)

In week view, work week days are displayed in white, Saturdays in blue, and Sundays in green.

In month view, today is displayed in yellow, work week days in green, week-end days in blue, and the next month's days in lilac.

Adding a new meeting, task, all day, or anniversary

Select **Menu** with the left selection key

Scroll to **New**

Push **Enter** (joystick) or Push Select with the right selection key

Scroll to the option that you want (Meeting, Task, All day, Anniversary) Meeting will be the most frequently used option. Task is for a to-do note. All day is for an all day event. Anniversary is for setting up reminders for birthdays, anniversaries or other important days that occur once per year. To-do notes, Anniversaries and all day events can be set up as a meeting. Training focuses on entering tasks in Meeting. Directions for using Task, All day, and Anniversary are provided below as an optional extra.

Meeting:

Scroll to meeting

Push **enter** (joystick) or push **Select** with the left selection key

Type the reminder that you want: For example, Occupational Therapy for an appointment with your OT

Scroll down once

Contact: Optional: Enter the name of who you are meeting with by entering it directly or

Push **Options** with the **left selection key**

Scroll to **Insert Contact**

Select the person from the list

Push **Enter** (joystick)

Scroll down once

Dates and Times: Enter the **start time** of the appointment

Scroll down once

Enter the **start date** of the appointment

Scroll down once

Enter the **end time** of the appointment – for some tasks the start and end times will be the same

Scroll down once

Enter the **end date** of the appointment – for most tasks the start and end dates will be the same

Scroll down once

Alarm: **Optional**: Select the **Alarm** option that you want by pushing the **right scroll-bar**

Scroll down once

Repeat: Optional: Select the **Repeat** option that you want by pushing the **right scroll-bar**

(Daily, Weekly, Month date, Month day, Year date, Year day, No Repeat)

Scroll down once

Select **1** for every day, week, month, or year

Select **2** for every second day, week, month, or year and so on.

Scroll down once

Select **Yes** for indefinite repeat (no end date) or

Select **No** for a specified end date – enter end date

Scroll down once

Category: Optional: Select **No category** or

Push **Enter** (joystick), scroll to desired category, push **Enter** (joystick), push **Back** with **right selection key**

Scroll down once

Notes: Optional: Enter notes, for example what to bring with you to an appointment, shopping list, or other reminder

Scroll down once

Domain: Optional: Push **enter** (joystick) – select None, Private, or Public, Push **Enter** (joystick)

Save: Push **Options** with left selection key
Select **Save** to save the entry or Cancel to cancel the entry
Push **Enter** (joystick) or Select with the left selection key

Editing a meeting, task, all day, or anniversary
Select the scheduled task or appointment in **Day view**,
Scroll to **highlight in blue**
Push **Enter** (joystick)
Push **Edit** with **left selection key**
Scroll to section and make desired changes
Push **Options** with **left selection key**
Push **Save**

For a recurring task: Select save changes to **This occurrence** or **All occurrences**
Push **OK** with left selection key

Deleting a meeting, task, all day, or anniversary
Select the scheduled task or appointment in **Day view**
Push **Menu** with left selection key
Scroll to **Delete (c)**
Push **Enter** (joystick)

For a recurring task: Select delete **This occurrence** or **All occurrences**
Push **OK** with right selection key

Closing Papyrus
Push **Menu** with left selection key
Scroll to **Exit,** Push **Enter** (joystick)

Papyrus – Task
Open Papyrus – right scroll-bar
Menu – left selection key
New
Enter – joystick
Scroll to Task
Enter – joystick
Type in To-do task
Scroll down
Select Due date, Start & Due, or Undated – right scroll-bar
Scroll down
Enter Start date
Scroll down
Enter Due date
Scroll down
Select alarm On or Off – right scroll-bar
Scroll down
Enter alarm time
Scroll down
Enter alarm date
Scroll down
Set priority as Normal, Low, or High – Right scroll-bar
Scroll down
Select Active, or Completed – right scroll-bar
Scroll down
Select Category – Enter (joystick), Scroll to category, Enter (joystick), Back with Right selection key
Scroll down
Type in notes
Scroll down
Select Private, Public or None – Right scroll-bar
Options – Left selection key
Save
Enter (joystick)

Papyrus – All Day
Open Papyrus – right scroll-bar
Menu – left selection key
New
Enter – joystick
Scroll to All day
Enter – joystick
Type in All day activity
Scroll down
Enter start date
Scroll down
Enter end date
Scroll down
Set Category – Enter (joystick), Scroll to category, Enter (joystick), Back with right selection key
Scroll down
Type in notes
Scroll down
Select Private, Public, None – right scroll-bar
Options – Left selection key
Save
Enter (joystick)

Papyrus – Anniversary
Open Papyrus – right scroll-bar
Menu – left selection key
New
Enter – joystick
Scroll to Anniversary
Enter – joystick
Type in Anniversary e.g. Mum's Birthday, or Wedding Anniversary
Scroll down
Enter date
Scroll down
Select Alarm – Right scroll-bar
Scroll down
Enter alarm time
Scroll down
Enter alarm date
Set Category – Enter (joystick), Scroll to category, Enter (joystick), Back with right selection key
Scroll down
Type in notes
Scroll down
Select Private, Public, None – right scroll-bar
Options – Left selection key
Save, Enter (joystick)

Using Microsoft Outlook

About Calendar

The Microsoft Outlook **Calendar** is the calendar and scheduling component of Outlook, and is fully integrated with e-mail, contacts, and other features. You can view a day, week, or month at once.

Opening the software

To open Microsoft Outlook Calendar:

Double click on the ***Microsoft Outlook Icon*** on your desktop

Click on ***Calendar***

Views

To select the view that you want:

Click on ***Day, Work week, Week, or Month*** in the top toolbar

Go to date

To go today:

Click on ***Today*** in the top tool bar

To go to a different date:

Click on the ***top arrows*** in the left Calendar toolbar to select the month and year you want

Click on the date

Adding a new appointment

Click on ***new*** in the top toolbar

Enter the name or task in the subject box

Enter the location in the location box

Select the date you want: for today click on ***Today***

For a different day click on the ***down arrow*** next to Start time and select the required date

Select the start and end times of your appointment:

Click on the ***start and end time down arrows*** and select the times required. Click in the ***all day*** box if this is an all day event

Click in the ***Reminder*** box if you want a reminder

Select when you want the reminder: Click on the ***down arrow*** in the reminder box to select how many minutes/hours/days before the event you want a reminder

Select the Show time as: Click on the ***Show time as down arrow*** and select the option that you want

To add notes: Click in the ***text box*** to add notes such as items to bring, or a shopping list and type in

To save: click on ***Save and Close*** if you want to close Calendar

Click on ***File, Save*** if you want to add more appointments

Recurrence: if this is a recurrent task, click on ***Recurrence*** in the top tool bar

Select your preferred recurrence pattern, range and end time

Remover recurrence: to remove a recurrence previously saved click on ***recurrence*** in top tool bar and click on ***remove recurrence***

Add contact: To add a contact to your appointment click on ***add contact***, select contact from list, click on ***OK***

Save: click on ***File, Save***

Edit an appointment

Double click on the ***appointment*** that you want to edit in any view

If it is a recurring appointment a pop-up box will prompt you to select edit this occurrence or edit this series. If you want to edit only one day select edit ***this occurrence***. If you want to edit every occurrence of the appointment select edit ***this series***

Make required changes

Click on ***safe and close*** on the top tool bar

Delete an appointment

Double click on the ***appointment*** that you want to delete in any view

Click on ***delete***

Click on ***OK***

If it is a recurring appointment a pop-up box will prompt you to select delete this occurrence or delete this series. If you want to delete only one day select ***delete this occurrence***. If you want to delete every occurrence of the appointment select ***delete this series***

Click on ***OK***

Send appointments to your phone

See synchronizing below

Using Nokia PC Suite

Open Nokia PC Suite by double clicking on the icon on your desktop.

Click on **Get Connected**

Click on **Next**

Select **Cable Connection**

Click on **Next**

Connect your phone and PC with the supplied data cable when prompted.

Select **PC Suite** on your phone.

Press **enter** (joystick on your phone). Wait until your phone is connected.

Synchronizing your Nokia phone and PC

Connect your phone and PC (see using Nokia PC Suite above)

Click on **synchronize** in Nokia PC Suite.

Select Microsoft Outlook.

Select the functions that you want to synchronize.

Click on **Synchronize now**.

Appointments, contacts etc saved in Microsoft Outlook will now be saved in Papyrus and on your phone's contacts list. Items entered directly onto your phone will be saved in Microsoft Outlook.

Appendix 7: Information Sheets

THE USE OF MOBILE PHONES TO COMPENSATE FOR ORGANISATIONAL AND MEMORY IMPAIRMENT IN PEOPLE WITH ACQUIRED BRAIN INJURY

PART I:

Methods People use for Assisting with Remembering

INFORMATION SHEET

This research is being conducted by Cornè Mackie as part of her Doctorate of Clinical Psychology work at Massey University, under the supervision of Professor Janet Leathem. You may wish to discuss participation with the Clinical Psychologist who first suggested it to you, or you may contact Cornè Mackie or Janet Leathem through the Psychology Clinic, Massey University, Wellington, on (04) 801 2794, extension 62035.

You are invited to participate in this study. The purpose of the study is to identify methods that people with acquired brain injury most commonly use to help with remembering everyday tasks. We are also interested in what methods you have found to be most useful. We hope that through this research we can better understand and assist people with memory difficulties that have resulted from acquired brain injury.

Taking part in this research will involve filling in a form asking you to check off which methods from a list of commonly used memory strategies (such as calendars, notebooks, mobile phone, and pagers). We also ask you to rate how useful any of the methods have been. Perhaps you use some methods not on the list and you are asked to add those. It takes approximately 5-10 minutes to complete the form. You will also be asked to fill out another questionnaire about how you feel about your current life circumstances. This will take approximately 10 minutes. You can complete these questionnaires after the study has been explained to you, or you may wish to participate at some later time. If you are over 16 years old, have a history of brain injury, and have some difficulties with remembering, you are welcome to participate in this study.

All information will be coded in such a way that other people will not be able to tell who participated in this research, and all record forms used in this study will be stored securely or destroyed at the completion of the project. The results of the research will be presented at conferences and published in professional journals so that other psychologists can learn from our findings. These will represent group findings from our research, and information that could identify you would not be presented.

If you do agree to take part, you have the right to decline to answer any particular question. You also have the right to withdraw from this research at any time. You are welcome to ask any question related to this study at any time. We acknowledge that you provide information on the understanding that your name will not be used unless you give permission to the researcher. If you would like a summary of the group results of this research when it is finished please provide your name and address below. Any treatment that you may be receiving at Massey University will not be affected by whether or not you take part in this research.

Please complete the consent form if you are agreeing to participate in the research

This project has been reviewed and approved by the Multi-region Health and Disability Ethics Committee, MEC/06/02/006. If you have any concerns about the conduct of this research, please contact Mr Jeremy Hubbard, Acting Chair, Massey University Campus Ethics Committee: Wellington, telephone 04 801 2794 x6358, email humanethicswn@massey.ac.nz.

Please feel free to contact the researcher if you have any questions about this study.

Thank you for your consideration,

Cornè Mackie (BA Hons)
Researcher

Janet Leathem (PhD)
Clinic Director
Professor of Neuropsychology

DECLARATION A TRIALS: COMPENSATION

In the unlikely event of a physical injury as a result of your participation in this study, you may be covered by ACC under the Injury Prevention, Rehabilitation and Compensation Act. ACC cover is not automatic and your case will need to be assessed by ACC according to the provisions of the 2002 Injury Prevention Rehabilitation and Compensation Act. If your claim is accepted by ACC, you still might not get any compensation. This depends on a number of factors such as whether you are an earner or non-earner. ACC usually provides only partial reimbursement of costs and expenses and there may be no lump sum compensation payable. There is no cover for mental injury unless it is a result of physical injury. If you have ACC cover, generally this will affect your right to sue the investigators.

If you have any questions about ACC, contact your nearest ACC office or the investigator.

THE USE OF MOBILE PHONES TO COMPENSATE FOR ORGANISATIONAL AND MEMORY IMPAIRMENT IN PEOPLE WITH ACQUIRED BRAIN INJURY

PART I:

Methods People use for Assisting with Remembering / Caregiver

INFORMATION SHEET

This research is being conducted by Cornè Mackie as part of her Doctorate of Clinical Psychology work at Massey University, under the supervision of Professor Janet Leathem. You may wish to discuss participation with the Clinical Psychologist who first suggested it to you, or you may contact Cornè Mackie or Janet Leathem through the Psychology Clinic, Massey University, Wellington, on (04) 801 2794, extension 62035.

You are invited to participate in this study. The purpose of the study is to identify methods that people most commonly use to help with remembering everyday tasks. We are also interested in what methods you have found to be most useful. We hope that through this research we can better understand and assist people with memory difficulties that have resulted from acquired brain injury.

Taking part in this research will involve filling in a form asking you to check off which methods from a list of commonly used memory strategies (such as calendars, notebooks, mobile phone, and pagers). We also ask you to rate how useful any of the methods have been. Perhaps you use some methods not on the list and you are asked to add those. It takes approximately 5-10 minutes to complete the form. You will also be asked to fill out another questionnaire about how well you feel your friend or relative is doing since their injury. This will take approximately 10 minutes. You can complete these questionnaires after the study has been explained to you, or you may wish to participate at some later time. If you are over 16 years old you are welcome to participate in this study.

All information will be coded in such a way that other people will not be able to tell who participated in this research, and all record forms used in this study will be stored securely or destroyed at the completion of the project. The results of the research will be presented at conferences and published in professional journals so that other psychologists can learn from our findings. These will represent group findings from our research, and information that could identify you would not be presented.

If you do agree to take part, you have the right to decline to answer any particular question. You also have the right to withdraw from this research at any time. You are welcome to ask any question related to this study at any time. We acknowledge that you provide information on the understanding that your name will not be used unless you give permission to the researcher. If you would like a summary of the group results of this research when it is finished please provide your name and address below. Any treatment that you, members of your family, or people in your care may be receiving at Massey University will not be affected by whether or not you take part in this research.

Please complete the consent form if you are agreeing to participate in the research.

This project has been reviewed and approved by the Multi-region Health and Disability Ethics Committee, MEC/06/02/006. If you have any concerns about the conduct of this research, please contact Mr Jeremy Hubbard, Acting Chair, Massey University Campus Ethics Committee: Wellington, telephone 04 801 2794 x6358, email humanethicswn@massey.ac.nz.

Please feel free to contact the researcher if you have any questions about this study.

Thank you for your consideration,

Cornè Mackie (BA Hons)
Researcher

Janet Leathem (PhD)
Clinic Director
Professor of Neuropsychology

DECLARATION A TRIALS: COMPENSATION

In the unlikely event of a physical injury as a result of your participation in this study, you may be covered by ACC under the Injury Prevention, Rehabilitation and Compensation Act. ACC cover is not automatic and your case will need to be assessed by ACC according to the provisions of the 2002 Injury Prevention Rehabilitation and Compensation Act. If your claim is accepted by ACC, you still might not get any compensation. This depends on a number of factors such as whether you are an earner or non-earner. ACC usually provides only partial reimbursement of costs and expenses and there may be no lump sum compensation payable. There is no cover for mental injury unless it is a result of physical injury. If you have ACC cover, generally this will affect your right to sue the investigators.

If you have any questions about ACC, contact your nearest ACC office or the investigator.

THE USE OF MOBILE PHONES TO COMPENSATE FOR ORGANISATIONAL AND MEMORY IMPAIRMENT IN PEOPLE WITH ACQUIRED BRAIN INJURY

PART II: Characteristics associated with successful electronic cognitive aids use.

INFORMATION SHEET

You are invited to participate in this study being conducted by Cornè Mackie as part of her Doctorate of Clinical Psychology work at Massey University, under the supervision of Professor Janet Leathem and Dr. Duncan Babbage. You may wish to discuss participation with Cornè Mackie or Janet Leathem through the Psychology Clinic, Massey University, Wellington, on (04) 801 5799, extension 62035.

The purpose of the study is to find out whether mobile phones can be used to help people remember everyday tasks. We are also interested in what factors predict the successful use of mobile phones to help people remember. We hope that through this research we can better understand and assist people with memory difficulties that have resulted from acquired brain injury. Taking part in this research will involve participating in training for the special use of the mobile phone, and an evaluation phase. You will be provided with a mobile phone and a pre-pay mobile airtime card for this study.

1. Training will involve: (approximately 30 to 40 minutes)
   - working with you until you can use the mobile phone and software confidently.
   - making a list with you, of the tasks and reminders that will be sent to your mobile phone during the evaluation phase.
   - Assisting you (and your caregiver, where appropriate) with entering these tasks onto the phone or onto a computer.

2. You will be asked to complete three questionnaires. The first asks questions about your feelings of control over your life; the second questionnaire about any difficulties that you are currently experiencing, and the third about the strategies or methods that you use to help you to remember both now and before the injury. It also asks you to rate how useful you think these strategies are. Other information about your injury and

any memory difficulties will be gathered from assessments previously conducted. It will take 30 to 40 minutes to complete all the questionnaires.

3. The evaluation phase will involve:
    - recording on a form how often you remember to complete the tasks on your list with the aid of those strategies that you normally use. You may *not* use the mobile phone to help you remember during this phase. This may take between one and three weeks.

    - a two-week period during which messages will be sent to your phone to help you remember. You will be asked to record how often you remembered the tasks on your list *with* the aid of the mobile phone. You will also be asked to complete a small number of other tasks, such as mailing a letter on a particular day.

    - a two week period during which you will be asked not to use the mobile phone to help you remember, and record how often you remembered the tasks *without* the aid of the mobile phone. This is necessary so that we can be confident that any changes in your everyday memory occurred due to the use of the mobile phone and not because of any other reason. This will enable us to assist other people in similar situations.

    - During the final two weeks of the evaluation phase, messages will be sent to your phone to help you remember. You will have to record how often you remembered the tasks. You can use the phone until the follow-up stage.

    - We will contact you two months later to record some follow-up information for a further two weeks. Messages will be sent to your phone to help you remember. You will have to record how often you remembered the tasks.

You will receive a reimbursement of $20 per visit to cover travel and parking costs incurred through your participation in this study. At the completion of the last two weeks of the follow-up stage, the mobile phone will become your property. If you decide to withdraw from the study you will have to return the mobile phone to the researcher. The phone will only be yours if you participate in the whole study. You may wish to continue using the phone and software to help you remember. The software was written for the specific phone and software updates are made available at the discretion of the software developer. Updates and software support will be available until November 2007 at the expense of the researcher.

Thereafter, updates and software support can be accessed on the developer's website: http://www.sbsh.net/products/papyrus/index.php?page=support. You can contact the researcher for the duration of the study during normal business hours if you are experiencing difficulties with the software or the phone.

All information will be coded in such a way that other people will not be able to tell who participated in this research, and all record forms used in this study will be stored securely or destroyed at the completion of the

project. The results of the research will be presented at conferences and published in professional journals so that other psychologists can learn from our findings. Information that could identify you will not be presented without your prior permission.

If you do agree to take part, you have the right to decline to answer any particular question. You also have the right to withdraw from this research at any time. You are welcome to ask any question related to this study at any time. You have the right to edit information that you have provided. We acknowledge that you provide information on the understanding that your name will not be used unless you give permission to the researcher. If you would like a summary of the results of this research when it is finished please provide your name and address below. Any treatment that you may be receiving will not be affected by whether or not you take part in this research. Please complete the consent form if you are agreeing to participate in the research.

If you have any queries or concerns regarding your rights as a participant in this study you may wish to contact a Health and Disability Advocate, telephone 0800 42 36 38 (4 ADNET)

This project has been reviewed and approved by the Multi-region Health and Disability Ethics Committee Application CEN/06/04/022.

Please feel free to contact the researcher if you have any questions about this study.

Thank you for your consideration,

Cornè Mackie (BA Hons)
Researcher

Janet Leathem (PhD)
Professor of Neuropsychology

DECLARATION A TRIALS:
COMPENSATION

In the unlikely event of a physical injury as a result of your participation in this study, you may be covered by ACC under the Injury Prevention, Rehabilitation and Compensation Act. ACC cover is not automatic and your case will need to be assessed by ACC according to the provisions of the 2002 Injury Prevention Rehabilitation and Compensation Act. If your claim is accepted by ACC, you still might not get any compensation. This depends on a number of factors such as whether you are an earner or non-earner. ACC usually provides only partial reimbursement of costs and expenses and there may be no lump sum compensation payable. There is no cover for mental injury unless it is a result of physical injury. If you have ACC cover, generally this will affect your right to sue the investigators.

If you have any questions about ACC, contact your nearest ACC office or the investigator.

Appendix 8: Consent Form

THE USE OF MOBILE PHONES TO COMPENSATE FOR ORGANISATIONAL AND MEMORY IMPAIRMENT IN PEOPLE WITH ACQUIRED BRAIN INJURY

CONSENT FORM

REQUEST FOR INTERPRETER

English	I wish to have an interpreter.	Yes	No
Maori	E hiahia ana ahau ki tetahi kaiwhakamaori/kaiwhaka pakeha korero.	Ae	Kao
Cook Island	Ka inangaro au i tetai tangata uri reo.	Ae	Kare
Fijian	Au gadreva me dua e vakadewa vosa vei au	Io	Sega
Niuean	Fia manako au ke fakaaoga e taha tagata fakahokohoko kupu.	E	Naka i
Samoan	Ou te mana'o ia i ai se fa'amatala upu.	Ioe	Leai
Tokelau n	Ko au e fofou ki he tino ke fakaliliu te gagana Peletania ki na gagana o na motu o te Pahefika	Ioe	Leai
Tongan	Oku ou fiema'u ha fakatonulea.	Io	Ikai
	Other languages to be added following consultation with relevant communities.		

1.1 I have read and I understand the information sheet dated 01/09/2005 for volunteers taking part in the study designed to identify the strategies people use to help with remembering. I have had the opportunity to discuss this study. I am satisfied with the answers I have been given.

1.2 I have had the opportunity to use whanau support or a friend to help me ask questions and understand the study.

1.3 I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time and this will in no way affect my *future health care/continuing health care*

1.4 I have had this project explained to me by ___________________

1.5 I understand that my participation in this study is confidential and that no material which could identify me will be used in any reports on this study.

1.6 I have had time to consider whether to take part.

1.7 I know who to contact if I have any side effects to the study.

1.8 I know who to contact if I have any questions about the study.

2.1 I wish to receive a copy of the results YES/NO

Participants should be advised that a significant delay may occur between data collection and publication of the results. Alternatively "I would like the researcher to discuss the outcomes of the study with me".
YES/NO

2.3 I agree to my GP or other current provider being informed of my participation in this study/the results of my participation in this study
YES/NO

3. I ____________________ (full name) hereby consent to take part in this study.

Date: ____________________

Signature: ____________________

Full names of Researchers: Cornè Mackie
Professor Janet Leathem - Supervisor
Dr. Duncan Babbage - Supervisor

Contact Phone Number for researchers: 04 8012494 (ext 62035)

Project explained by ____________________

Project role ____________________

Signature ____________________

Date ____________________

Appendix 9: Confidentiality Agreement

The use of mobile phones to compensate for organisational and memory impairment in people with acquired brain injury.

CONFIDENTIALITY AGREEMENT

I .... (Full Name - printed)

agree to keep confidential all information concerning the project: 'The use of mobile phones to compensate for organizational and memory impairment in people with acquired brain injury'.

I will not retain or copy any information involving the project.

Signature: .... **Date:** ....

Appendix 10: Shapiro Control Inventory Profiles

The general domain sense of control encompasses two specific scales: Positive Sense of control, e.g. the belief in one's ability to attain control in the future if you wish; and Negative Sense of control, which measures whether the perception of lost control where you once had control, losing self-control, lacking control of the environment, and the level of control of others over you. Domain specific sense of control comprises the domains as follows: Body: i.e. eating behaviour, appearance, exercise, and sexuality; Mind: thoughts, attention/concentration, stress and sadness; Interpersonal relationships: friends, significant other, children and family of origin; Self; Career: employment status, work habits and spending habits; Environment; and Other: drug and alcohol use, smoking, violent behaviour, gambling, and time management. Mode of Control status includes four quadrants: Positive Assertive, Positive Yielding, Negative Assertive, and Negative Yielding. Satisfaction with, and desire to change, mode of control and domain specific parameters are also measured. Earlier instruments, such as the Rotter LOC inventory (1960) measured human control as a single output: Locus of control, which is perceived to reside within the self or external to the self. Second generation tests such as the Wallston's Health Locus of Control demonstrated that sources of control such as self and others are not mutually exclusive. The SCI offers sources of agency of control information, rather than locus of control information. It determines to what extent one's sense of control emanates from one's own efforts, and to what extent it comes from others (i.e. family or friends, government or society, and a higher power such as religion, God, or spiritual beliefs).

Participant One

P1's negative sense of control was greater than that of the normative group, which suggested that he felt he was losing control in areas where he once had it and lacked control over his environment. Within specific domains his sense of control was comparable to healthy normals in *Body* (eating behaviour, physical appearance, bodily functions, general physical appearance, weight, and sexuality) and *Environment*. However his scores were lower in *Mind* (thoughts, attention, stress and sadness), *Relationships* (friends, significant other, children, family of origin), *Self*, *Career* (employment situation, work habits, spending habits), and *Other* (drug and alcohol, violent behaviour, gambling and time management), than that of healthy normals. Particular areas of concern were The way my body functions (very out of control); Sadness (Moderately out on control); Spending habits (very out of control); Violent behaviour (slightly out of control); and Management of time (very out of control).

His modes of control was in the normal range for Negative Assertive (i.e. selfish, pushy, rigid), but outside of range for Positive Assertive (i.e. assertive, confident, decisive), Positive Yielding (i.e. gentle, sensitive, accepting), and Negative Yielding (i.e. dependent, indecisive, past-oriented), which suggested over-reliance on less adaptive ways to achieve control. He used a negative assertive mode of control with low frequency, which compared favourably with healthy normals. However, he used both positive assertive and positive yielding modes on a lower frequency than healthy normals, and negative yielding with a higher frequency. His satisfaction with his mode of control fell below the range found among healthy normals. His desire to change his mode of control reflected that he wished to increase Positive Assertive and Positive Yielding modes and to decrease Negative Assertive and Negative Yielding modes of control. Parameters of concern in specific domains included Body (physical exercise; the way my body functions; sexuality), Mind (my thoughts; attention/concentration; stress; sadness), Career (spending habits), Relationships (with my significant other; with my children), Environment (the place where I live), and Other (violent behaviour; management of time). He expressed a need to actively change all these areas and accept none.

His motivation for control exceeded the normal range. He reported that he had an extremely high need for control. His desire to make change rather than accept areas of his life that he is dissatisfied with was greater than that of the healthy normal comparison group. His results suggested a stressful life situation involving extraneous factors over which he found he had little control, which resulted in great frustration. Items endorsed above the normal range included making a great deal of effort in order to try to stay in control of life; a strong desire to be in control; a fear of losing control; importance to give the appearance to other that his life is in control; achievement is important; liking things around him ordered and disliking ambiguity; liking as much information as possible before making decisions; and controlling anger better. Items endorsed below the normal range included it being important to control other people and situations; and having power. Related to motivation of control were over control and the desire to have less control. P1 scored higher than normal controls on being too aggressive and over-controlling, and lower on seeking risk, excitement and adventure; having too much self-control; and holding anger in even when you want to express it.

Participant 2

His negative sense of control was in the healthy normal range. Within specific domains his sense of control was comparable to healthy normals in Body, Mind, Relationships, Self and Environment. However his scores were lower in the Career and Other domains than that of healthy normals. Particular areas of concern were Employment Situation (moderately out of control), Spending Habits (Slightly out of control), Work Habits (very out of control), Drug usage (very out of control), Alcohol consumption (slightly out of control), Smoking (slightly out of control), Violent behaviour (Very out of control), Gambling (Very out of control), and Management of time (Slightly out of control).

His modes of control were in the normal range for Positive Assertive, Positive Yielding and Negative Assertive but outside of range for Negative Yielding. He used positive assertive and positive yielding modes of control with high frequency, and negative assertive mode of control with low frequency, which compares favourably with healthy normals. However, he used negative yielding (Indecisive, manipulated, dependent) with a higher frequency. He was satisfied with his mode of control. His desire to change his mode of control reflected that he wished to increase Positive Assertive and Positive Yielding modes, which are fairly typical in Western cultures. Parameters of concern in specific domains included Body (physical exercise; the way my body functions), Mind (my thoughts; attention/concentration; sadness), Self (the way I feel about myself); Career (spending habits), Relationships (with my friends; with my family of origin)' Environment (the place where I live), and Other (alcohol consumption; smoking; management of time). He expressed a need to actively change most of these areas. He accepted the following concerns: thoughts, attention/concentration, employment situation, and smoking.

His motivation for control fell within the normal range, which was neither too high (preoccupation with getting and maintaining control) nor too low (lack of desire for control). Items endorsed below the normal range included fear of losing control, it being important to have control over others, gathering as much information as possible before making important decisions, having power, and wanting to control anger better. Within the areas of over control and the desire to have less control he scored higher than normal controls on seeking risk, excitement and adventure, and lower on being too aggressive and over-controlling. P2 reported an appropriately balance between self-efforts to gain a sense of control and the efforts from others.

Participant 3

P3's negative sense of control was greater than that of the healthy normal comparison group. In particular, he expressed concern for lacking control in his environment and feeling that he was losing control in areas where he once had control. Within specific domains his sense of control was comparable to healthy normals in Body, Relationships, Self, Career, Environment, and Other. However his scores were lower in the Mind domain than that of healthy normals. A particular area of concern was Attention/Concentration (slightly out of control).

All four modes of control were in the normal range (Positive Assertive, Positive Yielding, Negative Assertive, and Negative Yielding). This suggested that he consistently used appropriate styles of thought and behaviour relative to achieving and maintaining control in his life. However, he reported concerns within specific domains. These included Body (physical exercise; the way my body functions, physical appearance, body weight), Mind (my thoughts; attention/concentration; stress; sadness), Self (the way I feel about myself); Career (spending habits), Relationships (with my family of origin), Environment (the place where I live), and Other (management of time). He expressed a need to actively change most of these areas, but to accept Physical exercise; the way my body functions; and Physical appearance.

His motivation for control fell within the normal range, which is neither too high (preoccupation with getting and maintaining control) nor too low (lack of desire for control). Within the areas of over control and the desire to have less control he scored higher than normal controls on seeking risk, excitement and adventure, and lower on wishing to let go of control and having too much self-control.

Participant 4

His negative sense of control was in the healthy normal range. However, he endorsed feeling that he is losing control in areas where he once had control to a higher degree than healthy normals. Within specific parameters his sense of control was lower in the Body, Mind, Career and Other domains than that of healthy normals. Particular areas of concern were Eating behaviour (Slightly out of control); The way my body functions (Very out of control); Physical appearance (Moderately out of control); Body weight (Moderately out of control); Sexuality (Moderately out of control); Attention/Concentration (Very out of control); Sadness (Moderately out of control); Spending habits (Slightly out of control); Gambling (Moderately out of control); and Management of time (Slightly out of control).

His modes of control styles were in the normal range (Positive Assertive, Positive Yielding, Negative Assertive, and Negative Yielding. He used positive assertive and positive yielding modes of control with high frequency, and negative assertive and negative yielding with low frequency, which compared favourably with healthy normals. His satisfaction within specific domain parameters was below that of the comparison group. His concerns included Body (eating behaviour; physical exercise; the way my body functions; body appearance; body weight; sexuality), Mind (my thoughts; attention/concentration; stress; sadness), Self (the way I feel about myself); Career (spending habits), Relationships (with my children; with my family of origin), Environment (the place where I live), and Other (violent behaviour, gambling, management of time). He expressed a need to actively change all of these areas and to accept none.

His motivation for control fell within the normal range, which was neither too high (preoccupation with getting and maintaining control) nor too low (lack of desire for control). He reported being satisfied with his level of self-control. Within the areas of over control and the desire to have less control he scored substantially higher than normal controls on being too aggressive and over-controlling, and having too much self-control, and lower on seeking risk, excitement and adventure.

Participant 5

P5's negative sense of control in the general domain was greater than that of the healthy normal comparison group. This indicated that her perceptions about lacking or losing control were great enough to restrict her perceptions and behaviours relative to sense of control. Within specific domains she endorsed feeling helpless and passive, and feeling that she is losing control in areas where she once had control, to a greater degree than healthy normals. Within domains her scores were below healthy normals in Body and Career areas. Particular areas of concern were Eating behaviour (Moderately out of control); Physical exercise (Moderately out of control); The way my body functions (Moderately out of control); Physical appearance (Very out of control); Body weight (Very out of control); and Employment situation (Very out of control).

Her modes of control were in the normal range for Positive Yielding, Negative Assertive and Negative Yielding, but outside of range for Positive Assertive. She used positive yielding with high frequency, and negative assertive and negative yielding modes of control with low frequency, which compares favourably with healthy normals. However, she was using positive assertive with a lower frequency than healthy normals. She was generally satisfied with how she used modes of control. Her desire to change her modes of control reflected that she wished to increase Positive Assertive and Positive Yielding modes, and decrease Negative Assertive and Negative Yielding modes of control. Parameters of concern within specific domains include Body (eating behaviour; physical exercise; the way my body functions; body weight), Mind (attention/concentration; stress; sadness), and Other (smoking; management of time). She expressed a need to actively change all of these areas other than the way her body functions.

Her motivation for control fell within the normal range, which is neither too high (preoccupation with getting and maintaining control) nor too low (lack of desire for control). Items endorsed below the normal range include it being important to have control over others, and having power. Items endorsed greater than the normal range, which suggested a need for over control, included making a great effort to stay in control of her life, a strong desire for control, giving the appearance that she is in control of her life, and gathering as much information as possible before making important decisions. Within the areas of over control and the desire to have less control she scored substantially higher than normal controls on wishing to let go of control, having too much self-control, and holding anger in even when she wants to express it; and substantially lower on being too aggressive and over-controlling and seeking risk, excitement and adventure.

Participant 6

P6 reported an overall sense of below that typically found with healthy individuals, which indicated a lower level of belief that he had the resources to achieve and maintain control in his life. Perceptions he had about lacking or losing control could have been sufficient to restrict his thinking and behaviour relative to control issues. He reported a level of self-control that was lower than that of healthy normals. His general level of self-efficacy (positive sense of control) was lower than that of the healthy normal comparison group. His negative sense of control was greater than that of the comparison group. Items endorsed higher were: Losing control of myself; being too passive and helpless, others having too much control over me; and feeling that I am losing control in areas where I once had control. Within specific domains his sense of control was lower than healthy normals in Body, Relationships, Self, Career, Environment, and Others. Particular areas of concern were Physical exercise (Slightly out of control); Physical appearance (Moderately out of control); Body weight (Moderately out of control); My thoughts (Slightly out of control); Attention/concentration (Moderately out of control); Stress (Slightly out of control); Sadness (Slightly out control); Work Habits (Slightly out of control), Relationship with significant other (Moderately out of control); Smoking (Slightly out of control), Violent behaviour (Slightly out of control), and Management of time (Slightly out of control).

His modes of control were in the normal range for Negative Assertive and Negative Yielding but outside of range for Positive Assertive and Positive Yielding. He used negative modes of control with low frequency, which compares favourably with healthy normals. However, he used positive modes of control with a low frequency. He was mostly satisfied with his mode of control. However, his desire to change his mode of control reflected that he wished to increase Positive Assertive and Positive Yielding modes, and reduce Negative Assertive and Negative Yielding modes. Parameters of concern within specific domains included Body (eating behaviour; the way my body functions, body weight), Mind (my thoughts; attention/concentration; stress; sadness), Self (the way I feel about myself); Relationships (with my significant other; with my family of children)' Environment (the place where I live), and Other (drug usage; smoking; violent behaviour; management of time). He expressed a need to actively change most of these areas, but accepted the following concerns: thoughts, attention/concentration, sadness, the way I feel about myself, the place where I live and drug usage.

His motivation for control fell within the normal range, which was neither too high (preoccupation with getting and maintaining control) nor too low (lack of desire for control). He did not endorse any items below the normal range.

P6 was experiencing his sense of control as coming from his own efforts to a lesser extent than that of a normal screened group. However, control was coming from others in his life to an extent comparable to or higher than that of healthy normals. He may have felt too reliant on others, to the exclusion of his own efforts.

Participants varied in their perceived control. Half showed below average overall sense of control, and half average. Three had an average level of self-efficacy and three a below average level of self-efficacy. For four participants Negative sense of control was above average and for two it was average. Four showed below average Modes of control and two were Average. For one participant Motivation for control was extremely high and for the remaining five it was in the average range. Agency for control from self was in the average range for half and in the below average range for half of the participants. Agency for control from others was in the average range for all six participants. These results are presented in Table 16.

Table 16
Participant by participant analysis of control and level of self-efficacy

	Overall sense of control	Self - efficacy (Positive sense of control)	Negative sense of control	Modes of control	Motivation for control	Agency for control – self	Agency for control – others	Level of Insight
1 P1	Below	Below	Above	Below	Extremely High	Below	Average	High
2 P2	Below	Below	Average	Below	Average	Average	Average	Low
3 P3	Average	Average	Above	Average	Average	Average	Average	High
4 P4	Average	Average	Average	Average	Average	Below	Average	High
5 P5	Average	Average	Above	Below	Average	Average	Average	High
6 P6	Below	Below	Above	Below	Average	Below	Average	Low

Appendix 11: Study 2 – Changes in everyday functioning

Table 17

Improvements in everyday memory function using the phone vs. no aids Baseline (A1) to Treatment (B1)

Participant	Mean	Standard Deviation	Direction	t	df	p	Eta Squared	Effect size
P1								
A1	0	.0	Increase	-13.85	9	<.0005	.95	Large
BI	9.7	2.2						
P2								
A1	0	.0	Increase	-18	9	<.0005	.97	Large
BI	6	1.1						
P3								
A1	1.9	.31	Increase	-21.9	9	<.0005	.98	Large
BI	7	.67						
P4								
A1	0	.0	Increase	-69	9	<.0005	.99	Large
BI	6.9	.32						
P5								
A1	5.2	.42	Increase	-28.2	9	<.0005	.99	Large
BI	9.5	.58						
P6								
A1	1.8	.42	Increase	-6.1	9	<.0005	.80	Large
BI	3.1	.32						

Table 18
Improvements in everyday memory function using the phone vs. no aids
Baseline (A1) to Treatment (B2)

Participant	Mean	Standard Deviation	Direction	t	df	p	Eta Squared	Effect size
P1								
A1	0	.0	Increase	-18.5	9	<.0005	.97	Large
B2	7.4	1.3						
P2								
A1	0	.0	Increase	-24.6	9	<.0005	.98	Large
B2	5.5	.7						
P3								
A1	1.9	.31	Increase	-15.65	9	<.0005	.96	Large
B2	5.4	.52						
P4								
A1	0	.0	Increase	-27.4	9	<.0005	.98	Large
B2	8.4	..96						
P5								
A1	5.2	.42	Increase	-17.58	9	<.0005	.97	Large
B2	9.3	.95						
P6								
A1	1.8	.42	Increase	-3.73	9	<.0005	.60	Large
B2	3.3	.95						

Table 19
Improvements in everyday memory function using the phone vs. no aids
Baseline (A1) to Follow-up (FU)[17]

Participant	Mean	Standard Deviation	Direction	t	df	p	Eta Squared	Effect size
P1								
A1	0	.0	Increase	-30	9	<.0005	.99	Large
FU	10	1.05						
P3								
A1	1.9	.31	Increase	-20.8	9	<.0005	.98	Large
FU	6.5	.58						
P4								
A1	0	.0	Increase	-30	9	<.0005	.99	Large
FU	10	1.05						
P5								
A1	5.2	.42	Increase	-17.57	9	<.0005	.97	Large
FU	9.3	.95						
P6								
A1	1.8	.42	Increase	-2.25	9	<.0005	.35	Large
FU	2.4	.52						

[17] Follow-up data was excluded for P2. He was not available for follow-up data collection as he moved and did not provide a forwarding address.

Table 20
Paired samples t-tests: Improvements in everyday memory function while using the phone vs. aids used traditional aids (excl reminders from others)
Baseline (A1) to Treatment (B1)

Participant	Mean	Standard Deviation	Direction	t	df	p	Eta Squared	Effect size
P1								
A1	7.3	.95	Increase	-6	9	<.0005	.80	Large
BI	9.7	2.2						
P2								
A1	0	.0	Increase	-18	9	<.0005	.97	Large
BI	6	1.1						
P3								
A1	1.9	.31	Increase	-21.9	9	<.0005	.98	Large
BI	7	.67						
P4								
A1	4	.0	Increase	-29	9	<.0005	.99	Large
BI	6.9	.32						
P5								
A1	.3	.48	Increase	-52.66	9	<.0005	.99	Large
BI	8.9	.32						
P6								
A1	7.9	.32	Decrease	24	9	<.0005	.98	Large
BI	3.1	.32						

Table 21

Paired samples t-tests: Improvements in everyday memory function while using the phone vs. aids used traditional aids (excl reminders from others) Baseline (A1) to Treatment (B2)

Participant	Mean	Standard Deviation	Direction	t	df	p	Eta Squared	Effect size
P1								
A1	7.3	.94	Increase	-1	9	.343	.012	Small
B2	7.4	1.27						
P2								
A1	0	.0	Increase	-24.6	9	<.0005	.98	Large
B2	5.5	.7						
P3								
A1	1.9	.31	Increase	-15.65	9	<.0005	.96	Large
B2	5.4	.52						
P4								
A1	4	.0	Increase	-16.5	9	<.0005	.97	Large
B2	8.4	.84						
P5								
A1	.3	.48	Increase	-19.9	9	<.0005	.97	Large
B2	8.4	.96						
P6								
A1	7.9	.32	Decrease	20.8	9	<.0005	.98	Large
B2	3.3	.48						

Table 22
Paired samples t-tests: Improvements in everyday memory function while using the phone vs. aids used traditional aids (excl reminders from others) [18]

Participant	Mean	Standard Deviation	Direction	t	df	p	Eta Squared	Effect size
P1								
A1	7.3	.95	Increase	-5.22	9	<.01	.75	Large
FU	10	1.1						
P3								
A1	1.9	.31	Increase	-20.8	9	<.0005	.98	Large
FU	6.5	.58						
P4								
A1	4	.0	Increase	-18	9	<.0005	.97	Large
FU	10	1.1						
P5								
A1	3	.48	Increase	-19.9	9	<.0005	.97	Large
FU	8.4	.97						
P6								
A1	7.9	.32	Decrease	-24.6	9	<.0005	.98	Large
FU	2.4	.52						

[18] Follow-up data was excluded for P2. He was not available for follow-up data collection as he moved and did not provide a forwarding address.

Appendix 12: Participant 7 Profile

Participant Seven (withdrawn from the study)

P7 is a 35-year-old female who was hit by a truck as she crossed the road four months ago. She had a GCS of 6/15 upon arrival at hospital. She suffered intracerebral hemorrhage characterized by dot hemorrhages and a small amount of subarachnoid and subdural blood, with a basal skull fracture. She did not require surgery. She began to gradually emerge from post traumatic amnesia three months post-injury. P7 resided in an inpatient rehabilitation facility during the time that this study was conducted. At the intake interview she reported predominantly physical injuries including motor dyspraxia and right-sided hemiparesis, and showed reduced insight into her cognitive difficulties and physical injuries. She did however report difficulties with everyday memory and concentration. A Neuropsychiatric assessment conducted two months post injury states that P7 displayed impaired insight. She denied a range of symptoms associated with her injury even though clear evidence of these difficulties was observed during the interview and formal assessment. These included impaired memory and concentration, and expressive language difficulties. Her communication abilities were characterized by fluent, monotone expressive language that was confabulatory at times. The report concluded that P7 has significant cognitive impairments and that her insight appeared distinctly limited and judgment unreliable. She has not had a Neuropsychological assessment done at the time of the study. She withdrew from the study after baseline data collection. She has agreed to the researcher including her data. She stated that she chosen to withdraw as she viewed her memory functioning as intact, and therefore did not need to use compensatory strategies. Her rehabilitation team felt that her withdrawal from the study reflected a severely impaired level of insight and self-awareness.

Appendix 13: Psychometric tests used to assess abilities in cognitive domains

Table 23

Psychometric tests used to assess abilities in cognitive domains

Domain	Test
Premorbid Ability	WAIS-III
Sustained attention	WAIS-III, Digit symbol
Selective attention	D-KEFS – Trail Making Test
Focussed attention	D-KEFS – Colour-Word Interference Test
Alternating attention	D-KEFS – Colour-Word Interference Test and Trail Making Test
Divided attention	D-KEFS – Colour-Word Interference Test
Visual memory	Rey-Osterrith Complex Figure Test (CFT).
Verbal memory	The Wechsler Memory Scale-III (WMS-III);
Working memory	WAIS-III, Digit Span; Auditory Verbal Leaning Test (AVLT)
Information processing speed	The STROOP word-colour interference test
Verbal reasoning	WAIS-III
Visual reasoning	WAIS-III, Block Design and Matrix Reasoning
Visuospatial Ability	WAIS-III- Block Design; CFT - copy
Executive functioning	D-KEFS, Twenty Questions and Sorting; BADS Zoo map; WAIS-III – Similarities and Picture Arrangement