SMS TEXT MESSAGING AS A MEANS OF INCREASING RECALL OF THERAPY GOALS IN BRAIN INJURY REHABILITATION & CLINICAL RESEARCH PORTFOLIO

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SMS TEXT MESSAGING AS A MEANS OF INCREASING RECALL OF THERAPY GOALS IN BRAIN INJURY REHABILITATION

& CLINICAL RESEARCH PORTFOLIO

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Computerised Memory Rehabilitation following Acquired Brain Injury: A Systematic Review

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(See Appendix 1)

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Abstract

Clinicians in the field of cognitive rehabilitation have long sought to discover if the computer may provide the key to the successful rehabilitation of memory deficits following acquired brain injury. A systematic review of the literature revealed 12 studies that were analysed to address questions of the effectiveness, maintenance, and generalisability of computerised memory rehabilitation. It is concluded that there is some limited evidence that computerised memory rehabilitation produces small improvements in performance on neuropsychological tests of memory. There is no evidence to suggest that improvements generalise beyond neuropsychological test measures to daily activities or that any changes in memory function endure over time without sustained and intensive input.

Key Words: Computerised memory rehabilitation; Traumatic brain injury

Introduction

Cognitive deficits are a significant cause of disability following acquired brain injury. Owing to the significant impact that impaired cognitive function has on an individual's functioning, thousands of research papers have been published documenting a catalogue of strategies and techniques which aim to improve quality of life. Following a severe brain injury, many individuals will receive rehabilitation. The World Health Organisation states that rehabilitation involves "the restoration of patients to the highest level of physical, psychological, and social adaptation attainable. It includes all measures aimed at reducing the impact of disabling and handicapping conditions and at enabling disabled people to achieve optimum social integration" (World Health Organisation, 1986 p. 785). Others such as McLellan (1991) and Wilson (1989) offer definitions in which the patient plays a more prominent role and where cognitive rehabilitation may refer to "any intervention strategy or technique which intends to enable clients or patients, and their families, to live with, manage, or by-pass, reduce, or come to terms with cognitive deficits precipitated by injury to the brain" (Wilson, 1989 p. 117).

Restoration Vs Compensation

Regardless of how rehabilitation may be defined, it is generally accepted that there are two broad approaches to cognitive rehabilitation - restoration and compensation (e.g. Blomert, 1998). Restorative approaches are those whose aim is to restore the normal, or near-normal, functioning of cognitive processes. Such approaches might include biological (e.g. pharmacological) interventions, or cognitive training interventions that involve intensive practice on tasks that make demands of the damaged cognitive system (e.g. attention, unilateral neglect, memory). This approach is based on the premise that there are sufficient cells and connections within the damaged brain to allow this process to occur (Robertson & Murre, 1999; Sabel, 1997) and damage is not so extensive as to prevent the restoration of function. However, while the plasticity of the brain following injury has been well documented (e.g. Kolb, 1995; Molginer et al., 1993) and the restoration or improvement of function may be attainable in some cognitive domains, rehabilitation has tended to direct interventions towards compensatory approaches.

The compensatory approach holds that the cognitive system may not be capable of being restored and therefore, rehabilitation should be focused on teaching the patient to compensate for their impairment in real life settings. Dickson and Backman (1999) viewed the general purpose of compensation as being to close the gap between the expected or required performance and the actual skill level of the patient. In an earlier paper, Dickson and Backman (1995) described compensation as occurring through four processes: remediation (increasing time, effort, or training to maintain or recover the affected skill), substitution (of a new or existing skill such that it replaces a defective skill), accommodation (adjusting priorities or criteria), and assimilation (altering the expectations of others, constructing forgiving environments). The effectiveness of such compensatory methods have been well documented in the literature (e.g. Cicerone, et al., 2005; Carney et al., 1999) and appear particularly well suited to those who are less impaired or suffer a more specific impairment, are younger in age, and have pre-morbid experience of using compensatory strategies (Evans, Needham, Wilson, & Brentnall, 2003).

Memory Rehabilitation

Memory and learning disorders are among the most common deficits following acquired brain injury and have salient implications for everyday functioning (Schacter, Glisky, & McGlynn, 1990). Over recent years, there have been three main areas of development in memory rehabilitation – those involving environmental adaptations, use of specific learning strategies, and the application of external aids, including new technology (Wilson, 1999). The environmental control model (Gross & Schutz, 1986) proposes that many of the difficulties encountered by those suffering memory impairment may be avoided by manipulating the environment through such measures as labelling cupboards and having appliances that turn off automatically. New learning can be facilitated in numerous ways such as using visual imagery for the acquisition of new names (Wilson, 1987) and through techniques such as association, backward chaining, expanding rehearsal (Landauer & Bjork, 1978) and errorless learning (e.g. Baddeley & Wilson, 1994). There have also been several technological innovations in recent years including ‘smart houses’ which provide a supportive and compensatory environment; NeuroPage, which is a paging system that has been shown to improve activities of daily living (Hersh & Treadgold, 1994; Wilson, Emslie, Quirk, & Evans, 2001) and computerised systems such as the Interactive Task Guidance System which guides those with memory impairments through complex tasks such as cooking (e.g. Bergman & Kemmerer, 1991).

Despite the advent of these approaches, the use of basic compensatory approaches remains the most commonly applied strategy within the rehabilitation setting and is probably the most effective strategy to use (Wilson, 1999; Cicerone et al., 2005). Compensation can be achieved through the use of external memory strategies such as diaries, notebooks, lists, and electronic prosthetic devices such as personal digital assistants (PDAs), pagers, and voice recorders etc. Mnemonics may also be used with the aim of enabling patients to organise, store, and retrieve information more efficiently (Wilson, 1999), although such methods tend not to be applied spontaneously. Regardless of the strategy adopted, it is likely that the brain-injured patient will require to be extensively trained on how to apply the strategy or procedure - a process which can be particularly time consuming. Several authors have attempted to bypass the high demands this places on the clinician’s time by utilising the limitless patience of the computer.

Use of the Computer

The computer has been used to complement more traditional methods of rehabilitation for over 45 years (e.g. Bortner & Birch, 1960). However, it has only been since the 1980s and the advent of the modern personal computer that such methods have generated viable rehabilitation strategies. Computers in the rehabilitation setting are advantageous in several ways (e.g. Burda, Starkey, & Domininguez, 1994; Smart, 1998) and have been used both to attempt to restore function and as a means of providing patients with the opportunity to practice compensatory strategies. It is important to draw a distinction between computerised memory rehabilitation and the use of computerised prostheses such as personal digital assistants, pagers, mobile phones etc. This distinction is key and can be overlooked in the literature. Computerised memory rehabilitation may be viewed as a 'treatment' – it seeks to improve memory performance and rehabilitate memory through repetitive practice. It aims to 're-train' the damaged memory system so that memory impairments are reduced or eliminated. As part of this process, the patient may 'exercise' memory by practicing basic memory skills such as remembering lists of words that are presented to them on the computer screen or they may repeatedly practice applying mnemonic strategies to stimuli presented by the computer. Following treatment it would be hoped that memory would have improved and operate at a functional level. Computerised memory rehabilitation in this review does *not* refer to the use of computerised prosthetic memory aids. The aim of such aids (e.g. personal digital assistants, pagers, mobile phones etc.) is not to rehabilitate memory *per se*, but to compensate for a deficit in memory. Prosthetic devices allow the patient to function independently despite the persistence of memory impairment and without the use of such devices, the patient's memory would still present as being impaired.

Recent advances in computer technology and the availability of relatively inexpensive hardware stimulated a minor resurgence in computerised memory rehabilitation since the initial studies of the 1980's (Bradley, Welch, & Skilbeck, 1993). Indeed, there has been an unexpected public interest in this area following the launch of the Nintendo DS which offers 'brain training' software. While the media at large suggest that repetitive practice on such games might improve and maintain intellectual function, there is currently a lack of scientific evidence to justify such claims. However, there is a growing evidence base suggesting computerised cognitive rehabilitation may lead to improved neuropsychological performance in schizophrenic patients (e.g. Kurtz, Seltzer, Shagan, Thime, & Wexler, 2007; Krabbendam & Aleman, 2003), although there does not appear to be sufficient evidence regarding the efficacy of computerised programmes designed to address attention deficits (Riccio & French, 2004).

Computerised Memory Rehabilitation

A search of the literature highlighted one review article that examined computerised cognitive rehabilitation in adults with acquired brain injury (Robertson, 1990). The review covered computerised cognitive rehabilitation in its entirety, including computerised memory rehabilitation. Three studies relating to computerised memory rehabilitation were discussed. Robertson (1990) concluded that there was no evidence that computerised memory therapy was effective and predicted a pessimistic future for continued research in the area. Despite this, research has persisted and several academic papers have been published over the last 18 years. This article aims to provide a systematic review of the effectiveness of computerised memory rehabilitation in adults following non-degenerative acquired brain injury. A literature search was carried out with the intention of investigating three questions: 1) How effective is computerised memory rehabilitation? 2) Are treatment gains maintained over time? 3) To what extent does the rehabilitation generalise to other settings?

Method

The Web of Science (1956 - January 2008), Embase (1980 – January 2008), Medline (1950 - January 2008), and PsychBITE (years 1975 - January 2008) databases were searched for English language papers using the key words “computer* rehabilitation”, ‘memory rehabilitation’, and ‘memory training’ in relation to ‘brain injury’. The same databases were also searched using the names of common training programmes (e.g. THINKable). Studies were included if they contained data specific to the area of computerised memory rehabilitation within the acquired brain injury population. Studies looking at the broader area of ‘computerised cognitive rehabilitation’ were included if they contained specific modules addressing the computerised rehabilitation of memory and outcome measures were provided. Interventions were sought which involved the patient repeatedly performing or practicing memory skills on a computer programme. Studies were excluded if they appeared to be focusing solely on working memory as such interventions tend to be directed towards the rehabilitation of the attentional structures that underlie working memory. Studies were also discounted if they were single case reports, focused on teaching patients *about* computers, focused on paediatric populations, or were editorials containing no data. Of the 608 potential references identified by the initial search strategy, 535 studies were excluded based on their title. The abstracts of the remaining 73 articles were read and eight articles were selected which met the inclusion criteria. The reference lists of these articles were analysed and a further seven articles were sought, of which three met the inclusion criteria. Book chapters and literature reviews were searched and resulted in the inclusion of one further study. This search procedure resulted in

12 studies being included in the review. The data from each study were examined regarding the patient population investigated; number of participants; duration and nature of computerised memory rehabilitation; type of control condition; primary outcome measures; and group differences. These data are presented in Table 1.

Level of Evidence – The PEDro Scale

Studies were assessed on the PEDro Scale. Initially devised to investigate the quality of physiotherapy Randomised Controlled Trials (RCTs), the PEDro scale is an 11- item rating scale that has proved to be effective beyond its initial field. Each item of the scale (except the first item) contributes to the total score that ranges between zero and ten. A recent reliability study by Maher, Sherrington, Herbert, Moseley, and Elkins (2003) found that the reliability of the total PEDro score was ‘fair’ to ‘good’ when rated by a panel of expert raters and contained a total score standard error of 0.07. This is similar to the reliability of other scales such as the Chalmers Scale (Bererd, Andreu, Tetrault, Niyonsenga, & Myhal, 2000) and the Jadad Scale (Jadad et al., 1996) and as such, may be regarded as offering a good estimate of an RCT’s quality. The PEDro scale ratings can be seen in Table 2. Scores for the 12 studies included in this review were between 1 and 4 (mode = 3). Ratings were made by the author and an independent rater. Tests of Inter-rater reliability were carried out on all of the twelve articles and showed 96 percent agreement. Inconsistencies were resolved by the raters reviewing the paper together and the final scores can be seen in Table 2. These scores were compared to independent PEDro ratings made by PsychBITE, an online neuropsychology literature resource. PsychBITE listed PEDro scores for seven of the twelve papers included in this review. There were two studies in which a one point discrepancy was noted. Inter-rater reliability remained high at 91%.

Categorisation of Studies

There exists a considerable degree of variability in the literature concerning the nature of the computerised intervention and there is often little information provided in relation to the theoretical underpinnings of the intervention e.g. restorative vs. compensatory. As such, studies have been categorised according to those that have computerised memory rehabilitation as their primary focus and those in which computerised memory rehabilitation is a part of a broader computerised cognitive rehabilitation programme. Nine of the studies used ‘strategy orientated task practice’ (Twamley, Jeste, & Bellack, 2003) in which patients repeatedly applied coached mnemonic strategies to computerised stimuli. One study appears to have involved no explicit application of strategies and patients were solely required to ‘exercise’ their memory by trying to remember stimuli presented by the computer (Towle, Edmans, & Lincoln, 1988). Two studies (Chen, Thomas, Glueckauf, & Bracey, 1996; Middleton, Lambert, & Seggar, 1991) did not provide sufficient details of their approach to allow accurate categorisation.

- Insert Table 1 about here -

- Insert Table 2 about here -

Results

Of the 12 studies reviewed, seven related specifically to the rehabilitation of memory and five contained computerised memory rehabilitation as part of a broader computerised cognitive rehabilitation programme. Of the seven studies focusing exclusively on the rehabilitation of memory, six reported positive results. However, three of these studies (Ruff et al., 1994; Marks, Patente, & Anderson, 1986; Towle, Edmans, & Lincoln, 1988) did not use adequate control populations with which to compare the documented improvement in memory performance. Of the five broader computerised cognitive interventions, two reported improved memory function in the treatment group on one key variable in comparison to a control population (e.g. Chen et al., 1996; Ruff et al., 1989). The three other studies, while documenting an improvement in memory following the intervention, either failed to use a control group (Giaquinto & Fori, 1992) or were unable to rule out the confounding effects of spontaneous recovery in their treatment and control groups (Middleton et al., 1991; Batchelor, Shores, Marosszeky, Sandanam, & Lovarini, 1988).

Computerised Memory Rehabilitation

As noted, of the seven studies that addressed the specific issue of computerised memory rehabilitation, six reported positive results. Dou, Man, Ou, Zheng, & Tam (2006) randomly assigned 37 patients to receive computerised training in basic memory tasks, mnemonic strategies, and the application of these strategies to daily life situations. A second group received similar, therapist-administered memory training and a third group formed a ‘no treatment’ control. Both treatment groups demonstrated improvements on the Rivermead Behavioural

Memory Test (Wilson, Cockum, & Baddeley, 1991) in comparison to the control group, with no differences between the two interventions. The computerised group did show an advantage on some aspects of the Hong Kong List Learning Test in comparison to the therapist-administered group and the control group. This study essentially demonstrated that computerised memory rehabilitation was as effective as traditional therapist administered methods. However, while documenting improvements in memory performance, reference to effect sizes may have complemented the findings. It was also of interest to note that while Dou et al. (2006) followed-up their patients at 30 days, they did not describe whether any improvements in memory function following the intervention were maintained over time.

The improved verbal memory function reported by Dou et al. (2006) was also found following the visual-imagery based technique of Goldstein, Beers, Longmore, & McCue (1996) who replicated an earlier study (Goldstein, et al., 1988) by re-running the design using computerised methods and using the initial study's patients as a control population. Two visual mnemonic techniques were used (the 'Ridiculous Imagined Story' (RIS) and a face-name learning association method) to try to improve recall. As was found in the initial, non-computerised study, the computerised intervention improved verbal recall as measured by the number of words recalled on a training measure. Unlike the earlier study, however, the computerised face-name learning method led to significant improvements. While benefiting from a well-matched control population, the generalisability of the findings are limited by the use of an archival control group and the use of different editions of assessments between the two studies. However, the study has to be noted as being one of the few in the literature that provides the reader with sufficient information to fully understand and replicate the intervention.

An interesting study was carried out by Tam and Man (2004) who designed a study to investigate some of the hypothesised benefits that computerised interventions offer i.e. that they are self-paced, provide feedback, can be personalised, and offer visual presentations. Twenty-six patients were randomly assigned into one of four treatment groups for ten, 20-30 minute training sessions in which they repetitively applied compensatory techniques to a range of important daily memory functions (e.g. remembering people's names and faces). While all groups showed improvements on the computerised training measures, no statistically significant improvements were documented in memory function as measured by the Rivermead Behavioural Memory Test (Wilson, Cockburn, & Baddeley, 1985). The absence of an improvement in memory function, as measured by neuropsychological test measures, following computerised rehabilitation is a relatively uncommon finding within the literature. The authors suggest the Rivermead Behavioural Memory Test may not have been sensitive enough to detect any potential improvements. Despite this, the intervention was relatively brief, lasting only ten sessions, and the results appear to document only small effect sizes. Not controlling for the high degree of variability within the treatment population on variables such as intelligence, educational background, and types of brain injury may have contributed to a dilution of any effect.

Ruff et al. (1994) investigated the usefulness of the attention and memory-retraining programme included within the THINKable software package. While the theoretical underpinnings of this intervention were not made explicit, Ruff et al. (1994) randomly assigned 15 patients to receive memory or attention rehabilitation in a counter-balanced order. Thus, half the sample received memory then attention rehabilitation and half the sample received attention then memory rehabilitation. Results of the interventions were combined for analysis purposes. Following 10 sessions (20 hours) of treatment, improvements in memory were evident as measured on training type measures although the authors note that these gains were small from a clinical perspective. There were significant improvements on neuropsychological measures of verbal and visuospatial learning but significance was not found on comparisons of performance on delayed trials. This study is the only one in the reviewed literature that used additional measures such as behavioural questionnaires in order to increase ecological validity. Unfortunately, despite such positives, the study's limited findings are detracted from by a lack of a control population, a small sample size with a significant number of dropouts, and a short period of exposure on the training programme. It was not possible to calculate an effect size for the intervention. However, an indication may be given by the limited clinical utility ascribed by the authors to the small improvements on the training measures and the loss of significant effects on delayed trials.

In contrast to the other studies involved in this review, Marks et al. (1986) sought to examine the effects of computerised memory rehabilitation when carried out by outpatients in their own homes. Ten patients received computerised memory rehabilitation for six months to one year for two to four hours per day and comparisons were made with a control population. The computerised software trained perceptual grouping, mental imagery, verbal mediation, and other forms of mnemonic memory strategies, although little information is provided regarding what the patient was required to do. Results showed that patients made significant gains in their memory quotient between pre-test and post-test as measured by the Wechsler Memory Scale (Wechsler, 1945). These improvements were maintained when the patients were followed-up six-months to one-year later. The positive findings reported by Marks et al. may have resulted from one of the most intensive interventions within the literature. However, the control group used in the study were only assessed once, thereby preventing the typical pre- and post-trial comparisons between treatment and control groups being made. As such, the effects of general stimulation cannot be ruled out as a contributing factor to the positive findings. Furthermore, while the two groups were matched on some demographic variables, statistical differences between the two groups are not reported and an absence of information regarding the severity of injury that the patients and controls had sustained further limits the extent to which one can generalise the findings. Further studies are required in order to document the long-term effects of computerised memory rehabilitation.

Towle et al. (1988) carried out a study examining the effectiveness of computer-presented games in retraining memory in memory-impaired stroke patients. Patients were not required to apply mnemonic strategies to the computer stimuli in this study. Rather, the rationale for the intervention appears to have been general memory stimulation through repetitive practice at remembering. Eleven patients were given computerised games to practice for 40 minutes each day for a maximum of four days per week. Patients had sustained their strokes just prior to treatment (mean = 26 weeks) and attended between 4 and 24 sessions (mean = 17.4 sessions). While individual patients showed improved memory function, there was only a limited group effect. Of the five pre- and post-intervention measures of memory taken by Towle et al., only one significant difference was apparent. Immediate prose recall improved from a mean of four items being recalled to a mean of 5.5. The authors rightly question the clinical utility of this finding and ultimately, the absence of a control population renders the study's findings open to alternative explanations such as spontaneous recovery, the novelty of the intervention, practice effects, or the effect of general stimulation.

One study was reviewed in which the theoretical basis and goal of the computerised intervention was unclear. While Kerner and Acker (1985) specified which software package they were using, they did not provide adequate details of the intervention to allow accurate categorisation of the computerised intervention. In addition to the twelve patients in their intervention group, Kerner and Acker employed both a computer control group (equal exposure to the computer to create pictures) and a control group receiving no treatment or exposure to computers. Following a 30 day computerised intervention, results showed that the twelve patients receiving the computerised treatment had improved their performance on Memory Span Word Recall (a training software outcome measure) and demonstrated significant improvements on some, but not all, sub-tests of the New York University Memory Test (Randt, Brown, & Osborne, 1980) in comparison to the computer control group. Patients were followed-up fifteen days after the study and the improvements in neuropsychological performance were not found to have been maintained for three out of four summary variables on the New York Memory Test. The inclusion of a computer-control group as well as a ‘no treatment’ control group should be encouraged as should the longer-term follow-up of patients. However, Kerner and Acker do not elaborate on, or control for, the reported difference in severity between the two groups, thereby introducing the possibility that pre-morbid factors could influence outcome. The study has also been criticised by Skilbeck & Robertson (1992) on the grounds that change scores for the two groups were compared without baseline scores being reported or controlled for.

Computerised Cognitive Rehabilitation

Five computerised intervention studies were found which provided data relating to the rehabilitation of memory as part of a broader computerised cognitive rehabilitation intervention. These approaches are often framed as being restorative in nature. However, with regard to the computerised memory rehabilitation modules, they appear to operate on similar principles as those interventions focusing specifically on memory in that they typically involve repetitive strategy-orientated task practice. The IBM programme called THINKable and the Psychological Software Services Package developed by Bracey (Bracey, 1982; Bracey, 1986) are perhaps two of the most common programmes discussed in the literature. THINKable is a multi-media programme that presents audio and visual stimuli for practicing cognitive skills. The therapist has control over the treatment parameters, being able to manipulate approximately 50 variables (Riccio & French, 2004). Feedback is provided during and after the training, on-going assessment is possible, and training tasks can be can be made more challenging as progress is made. The Bracey Process Approach has many similarities and consists of a range of sub-programmes addressing areas such as multiple attention, visual memory, spatial memory, paired associates, recognition-recall, as well as other domains of cognitive function such as sequencing and problem solving. Of the five studies of this nature discussed in this review, two reported improved memory function in the treatment group on one key variable in comparison to a control population (e.g. Chen et al., 1996; Ruff et al., 1989). Three other studies (Giaquinto & Fori, 1992; Batchelor et al., 1988; Middleton et al., 1991) also reported improvements in memory following computerised cognitive rehabilitation but suffer from methodological issues which reduce the weight one can place on their results.

Ruff et al. (1989) used a computer programme to try to improve neuropsychological functioning in the key areas of attention, spatial integration, memory, and problem solving. The memory module focused on retraining verbal and visual memory through the development of internal and external strategies. Computer programmes were specifically designed to provide stimuli to which mnemonic methods could be applied. The control group attended an equal amount of sessions as the computerised group but focused on psychosocial adjustment and activities of daily living, including playing computer games. Results showed significant improvements in the encoding of verbal information as measured by memory training measures as well and improved visuospatial recall as measured by neuropsychological outcome measures in comparison to the control group. As Ruff et al. had run the study as a pilot, the *p* value was set at 0.06. Neuropsychological function in the control population also improved and thus gives further weight to the use of ‘no treatment’ control groups as well as computerised placebo groups when conducting research in this field.

Chen et al. (1996) carried out a retrospective study of Bracy’s Process Approach by comparing assessment and outcome data in patient files with a control population from various rehabilitation centres in the local area. The treatment group received an unspecified amount of computerised retraining addressing attention, visuospatial abilities, memory, and problem solving while controls received traditional therapist administered rehabilitation. Both treatment and control groups improved on a range of neuropsychological measures across several cognitive domains, although only the computerised treatment group demonstrated a significant improvement on the delayed trial of logical memory. One must be cautious in placing weight behind such a retrospective analysis, particularly when there are significant differences between the treatment and control groups. No information is provided regarding the overall level of computerised training received by the patients in the treatment group and the absence of a ‘no treatment’ control means it is difficult to rule out the effects of spontaneous recovery given the global improvement in functioning reported in both groups.

Both the principles of repeated practice and specific strategy training were adopted by Batchelor et al. (1988) in which patients and matched controls were trained in the use of visual and verbal retention strategies as well as activities designed to promote improved executive functioning. Neuropsychological test performance was measured before and after 20 hours of computerised rehabilitation. Both patients and controls improved significantly on a range of neuropsychological outcome measures including the Wechsler Memory Scale (Wechsler, 1945). No significant differences were apparent between the two groups and the authors suggest that computerised cognitive rehabilitation is no more effective than non-computerised methods in remediating disorders of memory, attention, information processing, and higher cognitive functioning. It is difficult to rule out the effects of spontaneous recovery in this study, particularly because of the general improvements in neuropsychological function found in both groups and the fact that patients were less than three months post-injury.

Middleton et al. (1991) examined the effectiveness of a computer-assisted neuropsychological treatment targeting two different domains of cognitive rehabilitation - either attention and memory skills or reasoning and logical thinking skills. Following 8 weeks (32 hours) of computerised treatment, results for the 36 head injured patients showed significant improvements on five of six neuropsychological measures, including significant improvements in verbal paired associates. However, theses positive effects were noted regardless of which form of computerised rehabilitation patients had received, thereby implicating a general effect from cognitive stimulation. Given the mean length of time since injury was three years, it would be unlikely that the improved functioning would stem from spontaneous recovery. As the study did not mention how many patients were in each treatment condition and did not use a control population, it is difficult to place the improved neuropsychological and memory performance in context.

Giaqinto and Fori (1992) carried out one of the earliest studies using the THINKable programme with a broad range of patients including a sample of four patients with severe head injuries. Patients received five hours of computerised rehabilitation per week from four to twenty-four weeks. While the brain injured patients made significant gains on the Wechsler Memory Scale following training, important demographic variables were not discussed and little information was conveyed regarding what the patient actually had to do. Moreover, the lack of a control group means that it is difficult to know if the effect was due to the intervention, general stimulation, or the effects of spontaneous recovery.

Discussion

While there are a limited number of published studies looking at the area of computerised memory rehabilitation, many have been undertaken but not published in English or remain as doctoral theses - as evidenced by the manuals for many of the software packages. Furthermore, while many of the studies included in this review report positive outcomes, methodological limitations are common and often serve to detract from the generalisability of the findings. The following discussion aims to address the common methodological and theoretical shortcomings of the literature. Recommendations for future research are offered.

Details of Computerised Intervention

A recent survey of the ‘core’ medical rehabilitation journals noted that a common shortcoming in published intervention studies was the degree of conceptualisation or detail in the descriptions of treatment arms (Ddijkers et al., 2002). This is equally applicable to this current literature. In line with observations made by Twamley et al. (2003) in their review of cognitive training in schizophrenia, studies commonly neglect to state the goal of the intervention i.e. restoration of function or compensation. Within this review, only two studies (Dou et al., 2006; Goldstein et al., 1988) provide adequate details pertaining to specific compensatory strategies. However, they do not provide specific details regarding the computerised intervention. Some authors (e.g. Tam & Man, 2004; Ruff et al., 1994 & Giaqinto & Fori, 1992) provide information about the computerised intervention but do not discuss the underlying theoretical process through which memory and cognition may be improved. Even when sufficient details are provided regarding the computerised intervention, the broad range of computer programmes being used across the literature with varying duration and intensity means that it is hard to compare interventions and their results. While tailoring an intervention to the individual is a key part of cognitive rehabilitation, the inherent flexibility of computerised interventions, which initially offered such promise, may now be one of the factors preventing computerised rehabilitation realising its potential; for while rehabilitation in general must focus on the idiosyncratic presentation of the patient, the variability computerised interventions offer removes the uniformity and control which ‘Gold Standard’ treatments demand.

Duration of Intervention

The level of exposure to the intervention during computerised memory rehabilitation varies considerably. Indeed, estimates suggest that exposure varies from three hours (Tam & Man, 2004) to anything between 500 and 1000 hours (Marks et al., 1986). There is a similar level of variability within the broader computerised cognitive rehabilitation studies of which only a portion is devoted to memory. On average, computerised memory rehabilitation interventions tended to be briefer than the broader computerised cognitive rehabilitation interventions. The nature of the literature means it is difficult to ascribe a mean length of exposure to treatment. There is also variability in the length of time a patient is in rehabilitation more generally. The longer someone is in rehabilitation, the more they are exposed to its beneficial effects (e.g. Cicerone et al., 2005). Only one study (Chen et al., 1996) has addressed the comparable time in rehabilitation between the experimental and control groups. Future studies must try to control for such variations as well as establishing if the length of computerised treatment predicts subsequent change.

Sample Size

A common theme throughout the literature is the small sample sizes used. It is evident from Table 1 that studies contain anywhere between four and thirty-six participants, with an average of around twelve patients receiving the computerised treatment intervention across the twelve studies. None of the studies discussed in this review have referred to effect sizes - either predicted or found - and few of the studies presented data in a way that was conducive to calculating effect sizes independently. Effect sizes are an important issue for this literature as the majority of studies document positive results whilst using relatively small sample sizes suggesting large effect sizes. However it may be that large effect sizes only apply to outcome measures that are close in form to training measures and effect sizes for other outcome measures, particularly those reflecting everyday functioning may be much smaller. Reporting of such effect sizes is important in order that future studies can be properly powered.

Control Groups

The presence of a control group is widely regarded as being an essential component of a well-designed scientific experiment, particularly within the field of brain injury rehabilitation where the effects of spontaneous recovery and general stimulation can give the illusion of improvements resulting from an intervention. Within the current literature, four studies (Middleton et al., 1991; Ruff et al., 1994; Giaquinito & Fori, 1992; Towle et al., 1988) did not use designs involving control populations. Other studies show evidence of poorly matched control populations on variables such as chronicity (Chen et al., 1996), education (Batchelor et al., 1988), intelligence (Tam & Man, 2006), length of rehabilitation treatment (Chen et al., 1996), age (Goldstein et al., 1996), days in coma (Ruff et al., 1989), and pre-training memory skills (Tam & Man, 2006). Marks et al. (1986) used a control group that was not pre-tested, thereby limiting valid comparisons being drawn with the experimental group. Studies with more effective designs used control populations that received equal amounts of exposure on computerised placebo tasks such as drawing pictures (Ruff et al., 1989; Kerner & Acker, 1985). This said, there is evidence to suggest that exposure to a computer, interaction with a clinician, and non-specific cognitive challenge produce non-specific improvements in neuropsychological function (Kurtz et al., 2007; Ruff et al., 1989; Middleton et al., 1991). As such, computer control or treatment as usual groups may not provide a sufficiently inert population with which to compare the computerised intervention. Some authors included ‘no treatment’ control groups (Dou et al, 2006; Kerner & Acker, 1985). Such designs may have proved particularly useful in those studies where patients were very early on in their recovery (e.g. Batchelor et al., 1988) or those in which the effects of spontaneous recovery could not be ruled out. Other studies (Ruff et al., 1989) carried out repeated baseline testing to control for the confounding effect of spontaneous recovery. Overall, the lack of adequate control populations combined with the use of patients in the early stages of recovery mean that some studies have to be interpreted cautiously. Studies should seek to run both a placebo control computer condition as well as a no treatment condition which are matched on key prognostic variables.

Severity of Injury

Severity of injury is one of the most important variables in predicting recovery following an acquired brain injury (Levin, Gary, & Eisenberg, 1990; Katz, 1992). It can be seen from Table 1 that the severity of injury for the studies reviewed spans from mild to extremely severe with some authors (e.g. Giaquinito & Fori, 1992; Towle et al., 1988; Marks et al., 1986) not discussing this key variable at all. An array of terms and methods are used to describe and categorise severity of injury including coma duration (Chen at al., 1996), neuropsychological test results (Dou et al., 2006), and qualitative descriptions such as mild-severe (Kerner & Acker, 1985), severe (Ruff et al., 1994), serious

(Ruff et al., 1989) and severe-extremely severe (Batchelor et al., 1988). This variability means it is difficult to draw comparisons between studies. Closer control of this variable may allow the differential effects of computerised memory rehabilitation to be examined in reference to varying levels of severity.

Outcome Measures & Generalisation

Working from the premise that the ultimate goal of cognitive rehabilitation is improved functioning in real-life settings, showing improvement in neuropsychological measures is of limited value unless corresponding gains are made in the patient's natural context. Outcome measures have tended to fall under one of three categories: computerised software measures, neuropsychological test measures including more naturalistic measures such as the Rivermead Behavioural Memory Test (Wilson, Cockburn, & Baddeley, 1985), and behavioural memory questionnaires. None of the studies in this review relied exclusively on outcomes from training software, although when these were reported, they tended to report positive findings. The literature has tended to focus on pre- and post-intervention neuropsychological assessment measures. While these outcomes do have a bearing on ecological outcomes such as activities of daily living (e.g Heaton & Pendleton, 1981; McSweeney, Grant, Heaton, Prigatano, & Adams, 1985), the effects of computerised memory rehabilitation are often specific and subtle and it is bold to suggest that real world functioning will improve significantly because of a slight improvement on one or two neuropsychological subtests. Two of the more recently published studies (Dou et al., 2006; Tam & Man, 2004) have demonstrated an awareness of this complex issue by utilising the Rivermead Behavioural Memory Test, although both suggested that the test may be too blunt to detect the subtle changes in cognition brought about by computerised memory rehabilitation. Only one study (Ruff et al., 1994) has used a behavioural questionnaire as completed by the patients and their informants as an adjunct to more traditional measures. While patients tend to rate themselves as being less impaired on such measures (Allen & Ruff, 1990), the application of such measures should be incorporated into future studies. Improved ecological validity is likely to be key for the future success of this area of rehabilitation. Outcome measures such as the Rivermead Behavioural Memory Test and behavioural questionnaires should be encouraged as there is currently no evidence to suggest computerised memory rehabilitation generalises beyond selective improvements in neuropsychological assessments. It is likely that studies would have to be sufficiently powered to detect the probable smaller effect sizes that more naturalistic outcome measures may produce.

Maintenance

Only three studies included in this review discussed the key issue of maintenance. Kerner & Acker (1985) reported improved function on some aspects of the New York Memory Test (Randt, Brown, & Osborne, 1980) following treatment, but noted that these gains had not been maintained at 15-day follow-up. Dou et al. (2006) carried out a 30-day follow-up in their study but did not provide information as to whether improvements in memory function were maintained within treatment groups. Marks et al. (1986) found that improvements in memory function made during outpatient rehabilitation can be maintained over a six- to twelve-month follow-up period. However, the control group had no baseline data collected and so accurate pre- and post-treatment comparisons between treatment and control groups could not be made. Currently, there is only limited evidence to suggest that any gains brought about by computerised memory rehabilitation are maintained for any significant length of time. Furthermore, it may require a significant investment of patient and clinician time to observe such maintained gains. This is an important area for future studies to research as one may question the overall utility of this form of rehabilitation if improvements are not maintained.

Limitations of this Review

This review set out to examine the effectiveness of computerised memory rehabilitation following non-degenerative acquired brain injury. In doing so, inclusion criteria were kept broad to allow the inclusion of all of those studies evaluating memory rehabilitation exclusively or as part of a broader computerised cognitive rehabilitation programme. By including this latter category of study, some of the results presented in this review may not represent the isolated effect of computerised memory rehabilitation. Rather, some findings may be contaminated by other aspects of cognitive rehabilitation. However, it is unlikely that exposure to other forms of computerised cognitive rehabilitation would detract from any gains made through modules focusing on memory. It was felt that the inclusion of these studies has added to the understanding of the effectiveness of computerised memory rehabilitation and how the field may progress in the future.

Conclusion

Whilst computerised memory rehabilitation was still in its infancy, Bracey wrote: “While there are many therapeutic modalities that will serve to reorganise and enhance the [function of damaged] cognitive processes…none compare to the potential offered by the computer. The computer may be the most powerful tool in the area of cognitive rehabilitation” (Bracey, 1983, p. 7). Some twenty-five years later, it does not appear that this vision has been realised. While several studies demonstrate improved neuropsychological performance in comparison to control populations, the literature as a whole is plagued with methodological and theoretical shortcomings. Where improvements on neuropsychological test measures are documented, these appeared to be so selective as to have questionable ecological validity or be so global as to introduce the possible effects of spontaneous recovery. The weight one can place on the results is often curtailed by poorly matched or absent control populations. The findings of the literature are difficult to compare across studies owing to variability in the duration of computerised interventions on a range of different computerised programmes. There is a limited discussion of the goals and theory underpinning the research and poor control of important prognostic and demographic variables.

While the current literature has grown to the point of carrying out RCTs, these trials have stemmed from an evidence base in which many of the basic parameters of success are unknown. Adequately powered and well-designed RCTs are required which use a combination of no-treatment and computer-placebo control populations. Only when such studies have been conducted will we be in a position to document the effectiveness of computerised memory rehabilitation. As it stands, the methodological limitations of the literature prevent the potential effectiveness of computerised memory rehabilitation being known. Based on the current findings, there is some limited evidence to suggest that computerised memory rehabilitation produces small improvements in memory as measured by neuropsychological tests. There is no evidence to suggest that improvements generalise beyond neuropsychological test measures to daily activities or that any changes in memory function endure over time without sustained and intensive input.

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Table 2. PEDro Scale Ratings

PEDro Scale	Dou et al. (2006)	Tam & Man (2004)	Goldstein et al. (1996)	Ruff et al. (1994)	Towle et al. (1988)	Marks et al. (1986)	Kerner & Acker (1985)	Chen et al. (1996)	Giaquinto & Fori (1992)	Middleton et al. (1991)	Ruff et al. (1989)	Batchelor et al. (1988)
1. Eligibility criteria were specified	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No	No	No	Yes
2. Subjects were randomly allocated to groups	1	1	0	1	0	0	1	0	0	0	0	0
3. Allocation was concealed	0	0	0	0	0	0	0	0	0	0	0	0
4. The groups were similar at baseline regarding the most important prognostic indicators	0	0	0	0	0	0	0	0	0	0	0	0
5. There was blinding of all subjects	0	0	0	0	0	0	0	0	0	0	0	0
6.There was blinding of all therapists who administered the therapy	0	0	0	0	0	0	0	0	0	0	0	0
7. There was blinding of all assessors who measured at least one key variable	0	0	0	0	0	0	0	0	0	0	0	0
8. Measurements of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups	1	1	1	1	0	1	1	1	1	1	1	1
9. All subjects for whom outcome measurements were available received the treatment or control condition as allocated, or if not, data for at least one key outcome were analysed by "intention to treat"	0	0	0	0	1	0	0	0	0	0	0	0
10. The results of between-group statistical comparisons are reported for at least one key outcome	1	0	0	0	0	0	1	1	0	1	1	1
11. The study provides both point measurements and measurements of variability for at least one key outcome	0	1	1	1	1	0	1	1	0	1	1	1
Total	3	3	2	3	2	1	4	3	1	3	3	3

Chapter 2: Major Research Project

SMS text messaging as a means of increasing recall of therapy goals in brain injury rehabilitation

Prepared in accordance with the requirements for submission to:

Neuropsychological Rehabilitation

(See Appendix 1)

Submitted in Partial Fulfilment of the Requirements of the Degree of Doctorate in Clinical Psychology

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Abstract

A single-blind within-subjects trial was used to test the efficacy of sending SMS text messages to patients with a traumatic brain injury as a means of improving their recall of rehabilitation goals. Eleven participants were recruited from two community based rehabilitation centres and were sent text messages relating to three randomly selected goals from a selection of six current goals three times per day for fourteen days. Participants' recall of their rehabilitation goals was assessed at baseline, seven days, and fourteen days via free recall and cued recall procedures. Results showed that goals in the 'text condition' were recalled better than goals in the 'no text' condition. Practical applications and extensions are discussed.

Key Words: Prosthetic memory aids; Traumatic brain injury; Rehabilitation goals

Introduction

Neuropsychological rehabilitation has been described as ‘any intervention strategy or technique which enables patients and their families or carers to live with, manage, by-pass, reduce or come to terms with cognitive deficits precipitated by injury to the brain’ (Wilson, 1989, p. 117). Over recent years, the process of identifying and setting goals has become a defining feature of neuropsychological rehabilitation. However, despite widespread use of goal setting there has been limited research examining the specific impact of such procedures in rehabilitation services (Wade, 1998). A recent systematic review concluded that empirical evidence regarding the effectiveness of goal planning was ‘inconsistent and compromised by methodological limitations’ (Levack et al., 2006, p. 739). Another review concluded that there is some empirical support for goal setting, but that further work needs to be carried out to establish its reliability and sensitivity (Hurn, Kneebone, & Cropley, 2006).

Goals are thought to serve a directive function, focusing attention and effort toward goal relevant activities; they energise performance and by setting goals, people tend to persist more with a given task (LaPorte & Nath, 1976). Goal setting has been used extensively in organisational settings as a means of improving performance and has been adopted by rehabilitation services throughout the world. McMillan and Sparkes (1999) report that goal setting has contributed to meaningful treatment effects in several patient populations including adults with acquired brain injury (Ward & McIntosh, 1993); psychiatric patients (Houts & Scott, 1975); older adults (Barrowclough & Flemming, 1986); people with spinal injuries (Kennedy, Walker, & White, 1991); learning difficulties (Fuchs & Fuchs, 1986); and sports injuries (Theodorakis, Beneca, Malliou, & Goudas, 1997).

Within the neurorehabilitation setting, McMillan and Sparkes (1999) suggest that not only does the setting of specific, difficult goals lead to improved performance but goals also provide a meaningful outcome measure for health services. They recommend that both short-term and long-term goals should be set with goals being client centred, realistic, and attainable during admission within the rehabilitation setting. Goals should be clear and specific, have a definite time deadline, and must be measurable. While setting specific challenging goals maximises performance (Locke, Sari, Shaw, & Latham, 1981), it may also have the consequence of some goals not being met as was the case in McMillan and Sparkes review of a brain injury rehabilitation service in which 22% of long-term goals were not achieved.

Survivors of a brain injury often have difficulty in formulating and implementing relevant treatment goals (Gauggel, Konrad, & Wietasch, 1998) possibly owing to cognitive impairment. Indeed, impairments in memory, attention, and executive functioning are common after brain injury. Patients are thus vulnerable to forgetting to carry out intended actions (prospective remembering) either because they forget the content of the intention (what it is that should be done) or forget to carry out the action at the appropriate time. Similarly, patients may find it difficult to recollect goals set for rehabilitation and hence be less likely to carry out goal directed behaviours that would allow them to achieve their goals.

With respect to rehabilitation interventions aimed at improving prospective remembering, the majority of research has focused on compensatory strategies. Initially this meant ‘paper and pencil’ methods such as notebooks or planners (Wilson, 2000; Sohlberg & Mateer, 1989). However, as technology becomes more accessible and smaller, so its application within the brain injury setting has grown. Over the last ten years there has been a growing body of research documenting the effectiveness numerous ‘cognitive prostheses’ including personal digital assistants (Bergman, 2002), paging systems (Hersh & Treadgold, 1994; Wilson, Emslie, Quirk, & Evans, 2001); voice recorders (Hart, Hawkey, & Whyte, 2002) and mobile phones (Wade & Troy, 2001; Fish et al., 2007; Pijnenborg, Bosch, Evans, & Brouwer, 2007).

Despite the growing evidence base for newer technologies to support memory following acquired brain injury, only one study has examined an intervention aimed at improving memory for rehabilitation goals. Hart et al. (2002) demonstrated that a portable voice organizer could be used to help patients who had sustained a traumatic brain injury recall their therapy goals. The voice organiser alerted the participants three times per day through an audible tone. This tone prompted the participants to attend to a recorded message of a random selection of their goals. At a one-week follow-up, results showed that recorded goals were more easily recalled than unrecorded goals. Despite obtaining positive results, it appears that the use of a voice organiser was alien to the majority of participants and many required training in the use of this type of memory aid. Such difficulties could be avoided by utilising technologies with which the patient is already familiar.

Mobile phones are perhaps the most common and flexible prosthetic aid available to the rehabilitation clinician. In recent years, the number of people who use mobile phones and in particular use SMS text messaging has increased exponentially. Current estimates by mobileYouth.org would suggest that almost all young adults in the UK between the ages of 15 and 29 year own a mobile phone (J. Dhaliwal, personal communication, July 4, 2008). In 2007, the British public sent 57 billion text messages - this translates to around 1800 text messages being sent each second of every day of the year (The Mobile Data Association, 2008). As the highest risk of head injury is between the ages of 16 and 25 years (Sorenson & Kraus, 1991) it is likely that future survivors of acquired brain injury will be familiar and proficient in both the use of mobile phones and at communicating via text message.

Relatively few studies have been carried out in which the patient's mobile phone is used to improve or support impaired memory function. There is a sound evidence base upon which to base predictions that mobile phones and text messages may be an effective means of supporting impaired memory function. NeuroPage is a paging service that provides individualised text based pages to patients with acquired brain injury. Text prompts are sent to patients to engage either in a specific behaviour (e.g. fill in your diary) or provide a reminder of specific information (e.g. it's Thursday the 1st of May, 2008). The effectiveness of NeuroPage has been documented through randomised controlled trials (Wilson, et al., 2001) as well as single N designs (e.g. Evans, Emsile, & Wilson, 1998) which have all shown that text based messages can lead to statistically significant and real world improvements in remembering and carrying out daily activities.

Given such positive findings, some are beginning to realise that similar gains may be afforded by mobile phones and text messages. Pijnenborg et al. (2007) sent prompting text messages to a small sample of people with a diagnosis of schizophrenia as well as associated memory difficulties. In keeping with the NeuroPage literature, the five participants who completed the trial showed improved participation in daily activities following the introduction of the text message prompts. Fish et al. (2006) used text messages to improve prospective memory function in 20 brain-injured participants. Participants were sent ‘non-contingent’ text-alerts – a text message which said ‘STOP’ several times a day, but not at the specific time the action was required. Participants were trained to use the STOP text to cue them to undertake a brief mental review of current goals, including the main experimental task which was to make a phone call to a voicemail service four times a day at specified times. Results showed that performance was significantly better on those days participants received the text message containing the cue word than those days they did not. Studies like that of Fish et al. and Pijnenborg et al. suggest that text messaging is a familiar and effective means of both communicating with and reminding people of specific pieces of information as well as prompting specific actions. Based on this evidence, it was hypothesised that sending prompting text messages to patients’ mobile phones may be a useful way to improve the recall of rehabilitation goals in patients who were involved in rehabilitation following acquired brain injury.

Method

Design

Using a similar design to that of Hart et al. (2002), a within-subjects trial was used to examine the effectiveness of sending SMS text messages to participants with an acquired brain injury as a means of improving recall for their rehabilitation goals. It was hypothesised that participants would show improved free- and cued-recall for those goals for which text reminders were provided as compared to those goals for which no reminders were provided. Eleven participants were recruited from two brain injury rehabilitation centres. Participants were required to have six goals in order to participate - three goals were selected at random and sent to the participant by text message three times per day for fourteen days. Participants' memory for their goals was assessed at baseline, seven days, and fourteen days through free recall and cued recall procedures. Responses were transcribed and scored by a trainee clinical psychologist blind to the experimental condition. Ethical approval for both recruitment centres was granted by NHS Greater Glasgow Primary Care Division.

Participants

Eleven participants were recruited from two post-acute brain-injury rehabilitation centres in Scotland. Both centres offer goal-orientated approaches and set client-centred goals which typically focus on activities of daily living, and social, work, or vocational activities. One rehabilitation centre provides outpatient community-based rehabilitation while the other provides in-patient post-acute rehabilitation. Six participants were recruited from the community treatment centre and five were recruited from the in-patient centre. Participants were identified in both centres by the clinical service manager and a letter of invitation to participate was sent to them. They were offered the opportunity to participate if they met the following inclusion criteria: 1) had a documented acquired brain injury 2) had a memory impairment (documented by neuropsychological assessment or clinical judgement) 3) were actively participating in the rehabilitation programme 4) had at least six therapy goals set as part of their rehabilitation programme 5) were at least three months post injury and 6) owned a mobile phone. Potential participants were excluded if they: 1) displayed severe receptive or expressive language difficulties 2) were unable to reliably access text messages on their mobile phone 3) had significant difficulties with aggression 4) consistently failed to engage with their rehabilitation programme or 5) were under the Adults with Incapacity (Scotland) Act (2000) or were otherwise not able to provide informed consent.

Procedure

Once participants had been identified, a list of their current goals was reviewed. This was done by clinical staff members in the community treatment centre and by the researcher in the in-patient centre. Goals consisted of client-centred short-term and long-term goals which were expressed in a single sentence and at a level the participant could understand. If there were more than six goals, six were selected at random for inclusion in the study. Participants were then involved in setting cue words for each of the six goals before the study began. Cue words would be used in the ‘cued recall’ condition and were one-word summaries of the goal statement. The process of reviewing goals and assigning cue words occurred within the seven days preceding the baseline recall assessment of rehabilitation goals.

The researcher assessed each participant’s ability to access text messages on their mobile phone. This was done by sending the participant a text message and asking him or her to retrieve the message and read it aloud and in full. Three goals were then randomly selected to be allocated to the ‘text condition’. Six indistinguishable envelopes containing the numbers one to six were shuffled and the participant was asked to select three envelopes. The three selected goals were then entered on to an online text messaging service called textanywhere.net. This service has been used in previous research trials and has been found to be a reliable and time efficient way of managing such operations. Text messages were set to be delivered to participant’s mobile phone three times per day (9.30 am, 3.00 pm, 7.00 pm) for fourteen days. Participants received their first text message following the completion of the baseline assessment.

During the baseline recall assessment, participants were asked to tell the researcher as much as they could remember about their goals. In the cued recall condition, cue words were read out one at a time and participants were asked to recall as much information about the goal as they could remember, even if they had just recalled this information in the free recall section. Participants’ recall was recorded on a Dictaphone to allow accurate transcription of their responses. Standardised scripts were used during the recall sessions and are noted below. The script was altered slightly for the in-patient assessments as it was the researcher and not a clinician who had previously reviewed the goals and cue words with the participants.

Baseline Free Recall

When you last saw ________, they reviewed the goals that you are currently working on and asked you to keep that information in mind during this past week. I want to find out what you can remember about the goals that you are working on. Can you tell me as much as you can remember about the goals that you are working on as part of your rehabilitation programme?

Seven- & Fourteen-day Free Recall

As you know, you have been receiving text messages containing three of your goals for seven / fourteen days now. I want to find out what you can remember about the various goals that you are working towards – both the ones that you have received text messages about and the ones you have not received text messages about. Can you tell me as much as you can remember about the goals that you are working on as part of your rehabilitation programme?

Cued Recall

When you met with _________, they also set some cue words. These cue words summarised each goal and sometimes help people remember. When I read out the cue word, I want you to tell me as much as you can remember about that goal, even if you have told me about it a minute ago. Ready?

Participants free-recall and cued-recall was scored in accordance with the criteria used by Hart et al. (2002, p. 563) whereby participants were awarded points based on accuracy of recall. Scores were ascribed according to the content of the recall rather than the verbatim accuracy. Three points were awarded if the response mirrored the original goal statement in terms of ideas and accuracy of content. A score of two points was awarded if the participant recalled the general theme of the goal but was unable to provide specific details or their answer showed evidence of intrusions or distortions. One point was awarded if the participant demonstrated a basic awareness of the goal but demonstrated significant distortions in content or was lacking in specific details. A score of zero was awarded if the participant provided a "don't know" response or their recall did not reflect the goal in any way. This information along with scored examples can be seen in Appendix 2.4. Transcripts of the participants recall was scored by a trainee clinical psychologist not involved in the research study and who was blind to the condition of the participant's response (i.e. whether goal statements had been prompted by text messages). Thus, while the researcher collected the data from participants they had no influence over the actual scoring of responses. As such, the study may be considered as being a single-blind trial. Staff at both rehabilitation centres were also blind to the condition of each of the six goals.

Feedback was requested from participants regarding their subjective opinion of the efficacy of the intervention, the ease of use of this type of reminding, and their general impression of being sent reminding text messages each day. Feedback was sought at each of the three assessment meetings. Participants were also provided with the opportunity to voice any technical problems relating to their use of their mobile phone or receipt of text messages.

Results

All eleven participants who were recruited to the study completed all three assessments and were able to reliably access messages on their mobile phone at the time of baseline assessment. Potential reliability issues were highlighted regarding two participants' ability to access text messages on their mobile phone. In order to assess their reliability they were sent practice messages containing basic orientation information (e.g. 'It's Monday the 1st of May, 2008') three times per day for 7 days. Feedback from the rehabilitation staff members suggested text messages were being accessed reliably. No such assessments were deemed necessary for other participants. No delivery failures of the text messages were reported. Demographic information for the participants can be seen in Table 1.

- Insert Table 1 about here -

Participants one to six were recruited from the community treatment centre. Participants' ages ranged from 18 to 60 (mean =36; SD = 14). Eight males (73%) and three females (27%) were recruited. Injuries were predominately classified as severe to extremely severe (based on coma duration or length of post-traumatic amnesia) and were attributable to a range of aetiologies. General intellectual ability was estimated using either clinical records or the administration of the Wechsler Test of Adult Reading (WTAR) (Wechsler,

2001) or educational background. Pre-morbid ability levels ranged from the low average to high average range. Owing to the small sample size, statistical comparisons could not be made between participants from each of the two centres. By looking at Table 1 it can be seen that there was little difference between levels of pre-morbid ability, time since injury, type of injury, or severity in the two populations. Fewer female participants were recruited from the community treatment centre versus the in-patient centre. Discussion with the two centre managers would suggest that the current sample was representative of the local population requiring brain injury rehabilitation.

Participants' responses for the free recall and cued recall assessments at baseline, seven days, and fourteen days were summed. In each of the free recall and cued recall conditions, scores could range between zero and nine. Visual inspection of the data showed they were not normally distributed and owing to this, parametric statistics would not be appropriate. Additionally, Bryman and Cramer (1990) suggest that it is desirable to use non-parametric measures when the sample size is less than fifteen and so the data were analysed accordingly.

The median scores for free recall and cued recall of therapy goals in the text and no-text conditions across each of the three assessment points are shown in Figures 1.1 and 1.2 respectively.

- Insert Fig 1.1 about here -

- Insert Fig 1.2 about here -

Free Recall

A Friedman nonparametric repeated measures analysis of variance by ranks was used to analyse participants' free recall scores in the text and no text condition over time (i.e. baseline, 7 day, and 14 days). The effect of the text condition over time was significant (p = .002, Friedman test statistic = 10.95). There was no effect over time in the no text condition (p = .055, Friedman test statistic = 5.6).

Comparisons between participants' free recall in the text and no text condition were analysed by a Wilcoxon Signed Ranks Test. There was no significant difference in participants' free recall of their goals between the text and no text condition at baseline (z = - 0.141, p = .888). At both 7 and 14 days, participants recalled significantly more goal related information for those goals in the text condition as opposed to the no text condition (z = -2.077, p = .038; z = -2.825, p = .005). Effect sizes were calculated using z-scores and were found to be large at both seven days (r = 0.62) and fourteen days (r = 0.85). The nature of the improvement over time in the text condition was analysed by an additional Wilcoxon Test. Results showed that text prompts led to significant improvements in recall between baseline and 7 days (z = -2.318, p = .02) but not between 7 days and 14 days (z = -7.19, p = .472). This would suggest that the majority of improvement brought about by the intervention was achieved during the initial 7 days. This was confirmed by effect sizes which where large between baseline and 7 days (r = .69) but relatively small (r = .21) between 7 days and 14 days.

Cued Recall

The same statistical procedures were applied to the cued recall condition as those outlined above. A Friedman nonparametric repeated measures analysis of variance by ranks was used to analyse participants' cued recall scores in the text and no text condition over time (i.e. baseline, 7 day, and 14 days). The effect of the text condition over time was significant (p = .002, Friedman test statistic = 12.66). There was no effect over time in the no text condition (p = .105, Friedman test statistic = 4.51).

Comparisons between participants' cued recall in the text and no text condition were analysed by a Wilcoxon Signed Ranks Test. There was no significant difference in participants' cued recall of their goals between the text and no text condition at baseline (z = - .271, p = .78). At both 7 and 14 days, participants recalled significantly more goal related information for those goals in the text condition as opposed to the no text condition (z = -2.124, p = .034; z = -2.384, p = .017). Effect sizes were found to be large at both seven days (r = 0.64) and fourteen days (r = 0.71). As with the free recall condition, a Wilcoxon Test showed that text prompts significantly improved participants' cued recall between baseline and 7 days (z = -2.056, p = .04) but not between 7 days and 14 days (z = -1.582, p = .11) again indicating that the majority of benefit had occurred by the seventh day of the intervention. This was confirmed by effect sizes which were large between baseline and 7 days (r = .61) and medium-large between 7 days and 14 days (r = .47).

Participant Reactions

All eleven participants reported positive feelings about using their mobile phone as a means to support their memory impairment. Typically, participants' feedback fell into three categories: 1) improved subjective memory for goal related information 2) being alerted and motivated by the messages and 3) increased goal directed behaviour. In regards to memory function, the majority (nine) of participants felt that their memory for the goals sent to them by text messages had improved and that overall, the intervention had benefited them. Some (four) participants reported that the text messages triggered memories of their other goals that were not being prompted. The process of assigning cue words to each of the goals was reported by one participant as being particularly helpful in guiding their subsequent recall. Participant feedback also suggested that the receipt of text messages had an alerting and orienting quality. Several (five) participants reported that the daily reminders of their goals made them take stock of what they were doing and think about their various goals while a smaller proportion (two) reported links between the receipt of text messages and engaging in goal related behaviour. Other participants (four) reported that the routine of the texts arriving at the same time each day helped to orientated them to time.

While all eleven participants provided positive feedback about the use of text messages as a means of supporting their memory impairment, one participant thought that his diary was sufficient to help his memory and was concerned that introducing other strategies may lead to him becoming confused. Another participant felt a sense of anti-climax when he received text messages about his goals when expecting a message from a friend or relative. None of the participants felt the intervention was unhelpful or thought the messages significantly impinged on their day-to-day activities.

Discussion

This study was devised after it became apparent that despite widespread use of goal setting within the field of brain injury rehabilitation, little was known about how much information patients actually retained about their rehabilitation goals. Results showed that participants had very poor recall of their goals at baseline with free recall approaching floor levels. After seven days however, participants' free recall and cued recall was significantly greater for those goals that were prompted by text messages as compared to those goals that were not prompted. Although only eleven participants were recruited, large effect sizes were found in both free recall and cued recall conditions at seven days and fourteen days respectively. This pattern of results is similar to that of Hart et al. (2002) and suggests that despite having significantly impaired memory function, providing regular reminders of rehabilitation goals can significantly improve participants recall for this information.

While the effect of the text condition on recall was clear, it can be seen from Figures 1.1 and 1.2 that there is a small but steady increase in the recall of 'no text' goals in both the free recall and cued recall conditions. This pattern was also reflected in participants' feedback. For some, the effect of receiving the text messages often led them to think about their goals more generally, including those goals which were unprompted. The arrival of the text messages appears to have had an alerting quality similar to the effect intentionally created by Fish et al. (2007). While participants in the Fish et al. study were taught to undertake an ‘executive review’ when they received their text prompt containing the word ‘STOP’, this process appears to have been generated automatically in some of the participants in the current study. Thus, on receipt of the text message, some participants would not only think about their three prompted goals but also about their non-prompted goals and how they were progressing towards this end. For some participants, the mere sound of their mobile phone indicating a text message had arrived was enough to prompt them into this type of goal review. This type of conditioned response has also been noted by Evans et al. (1998) in their work with patient RP.

Advantages of text messages

This study has demonstrated that SMS text messages can be used to remind people of specific information i.e. their rehabilitation goals. However, it is clear that prompting and reminding patients by text message may hold significant potential within the field of brain injury rehabilitation. In comparison to other text based systems (e.g. NeuroPage) or prosthetic devices (e.g. voice recorders, PDA’s) utilising the patient’s mobile phone to receive prompting messages may hold key advantages. Firstly, as mobile phones are a part of modern life, patients are unlikely to be required to learn how to use a new device. Secondly, anecdotal evidence would suggest that many patients find mobile phones more socially acceptable than other prosthetic devices. Thirdly, the mobile phone has other useful mnemonic properties such as diary functions, cameras, and many now offer route finding programmes, although for some patients, such an array of functions may be overwhelming and distracting. The findings of Pijnenborg et al. (2007) suggest SMS text message prompts may be as efficacious as NeuroPage in prompting people with impaired memory function to participate in activities of daily living. In recognition of this shift, the service that provides NeuroPage reminders now offers an SMS text-based service too. The benefits associated with the use of SMS text messages and mobile phones with the brain injured population are likely to be attainable while preserving the cost savings, increased independence, quicker discharges from acute rehabilitation services, and reductions in stress that have already been established through other text based services such as NeuroPage (Wilson, et al., 2001). However, many patients who use NeuroPage derive benefit form the fact it is a ‘specific’ memory aid and its very uniqueness and novelty may be one of the reasons patients pay attention to the messages that are sent to the device. The same cannot be said for the ubiquitous mobile phone. While the feedback provided by participants in this study would suggest that messages are well attended to, a case may be made for further research in this area.

Limitations

Because this study took place alongside participants’ active involvement in rehabilitation programmes, some variables could not be controlled. For example, it was not possible to control the length of time the goal had been set for prior to its inclusion in the trial. Some participants were recruited early on in their involvement with the rehabilitation centres and as such, would have had a ‘new list of goals’. Other participants who had been involved in rehabilitation for a longer period may have been working on some of their goals for a number of weeks prior to them being used in the trial. This does not appear to have influenced the level of recall given by participants however as shown by the near floor level of recall during the baseline assessment. Other variables such as the length of time between participants having their goals and cue words reviewed and participating in the baseline recall assessment were also uncontrolled. Additionally, it was not possible to create a consistent time gap between participants receiving text messages and then participating in a recall assessment. Thus, some participants may have received a reminding text message in the waiting room prior to assessment while others may not have received one for several hours. Given the general improvement in recall that would have amassed from the previous days and weeks of receiving reminding text messages, it is thought that this variability is likely to have had minimal effect on the results.

Other areas of potential bias relate to the reliability with which participants accessed and read in full the text messages that they were sent. One participant suggested that they only gave the text messages a tertiary glance towards the end of the fourteen day trial. However, others' self-reports and large effect sizes suggests participants must have read their messages. This does not mean every future patient to use such a reminding system would be as thorough and steps should be incorporated into any clinical use of this text-based system to ensure adherence to the strategy.

This study did not seek to collect in depth quantitative data regarding the cognitive, physical, and behavioural difficulties of participants outside of basic demographic characteristics. While Hart et al. (2002) highlighted the need to investigate the optimum patient parameters regarding those who may benefit from using voice recorders as memory aids, it was thought that patients' pre-morbid familiarity with mobile phone technology would afford participants with a buffer against some of the cognitive impairments resulting from their brain injury. The findings from this study would suggest that participants with a wide range of cognitive and physical disabilities following brain injury may retain their ability to use their mobile phone effectively. Indeed, only two participants required support in the initial stage of the study to reliably access text messages. One participant's difficulties were related to limited pre-morbid experience of using a mobile phone and reduced confidence post-injury. Concerns were raised regarding another participant owing to limited existing use of a pager. However, these difficulties were not found when messages were delivered to his mobile phone.

No measures were taken to document any perceived improvement in goal related behaviour either during or following the study and it was not possible to examine the effect of improved recall on goal attainment. As around half of the participants were recruited from a community based rehabilitation setting, their behaviour could not be observed directly and attributing ratings of goal related behaviour solely on participants' self-report would have introduced a significant degree of bias. While some participants' feedback suggested that receiving the text messages led them to be more mindful of what it was they were working towards, there were relatively few reports of the texts directly prompting participants into goal related behaviour. This is not surprising given the study was described to participants as a memory study and not one to prompt behaviour. While the short duration of the study prevented the effect of improved recall on goal attainment being examined, this relationship requires further study. One would imagine that improved recall and goal knowledge would translate into improved goal attainment. However, such effects may be small and therefore difficult to isolate from the broader benefits gained through rehabilitation.

Conclusion

There is obvious value in increasing participants' awareness of their rehabilitation goals in terms of focusing attention and effort toward goal relevant activities. This study has clearly shown that the first step in this process can be facilitated by sending participants reminding text messages to their mobile phones. This method of reminding has been shown to be effective, well received by participants, and ecologically valid. Finding an effective way to encourage and prompt participants to participate in goal directed behaviour is a key part of the rehabilitation process and further research is required to demonstrate whether increased goal based knowledge translates into increased goal directed behaviour and attainment.

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Table 1: Participant Demographics

Participant	Age	Gender	Time since injury (months)	Type of Injury	Severity of injury	Estimated pre-morbid IQ
1	27	Male	8 months	TBI – fall	Severe	High average
2	18	Male	11 years	TBI - RTA	Very Severe	Low average
3	20	Male	8 months	TBI - RTA	Very Severe	Low average
4	19	Male	5 months	TBI - fall	Moderate	Average
5	47	Male	16 years	RTA	Very Severe	Average
6	43	Male	10 months	TBI – ARF*	Severe	Low average
7	35	Female	8 months	Anoxic	Very Severe	Low average
8	28	Female	5 months	TBI – RTA	Severe	Average
9	60	Female	6 months	Anoxic	Very severe	Average
10	48	Male	3 months	TBI – ARF*	Very severe	Low average
11	53	Male	7 months	TBI – ARF*	Extremely Severe	High average

* ARF = Alcohol related fall

Figure 1.1: Boxplot showing the free recall medians and interquartile ranges for text and no text conditions at baseline, 7 days and 14 days.

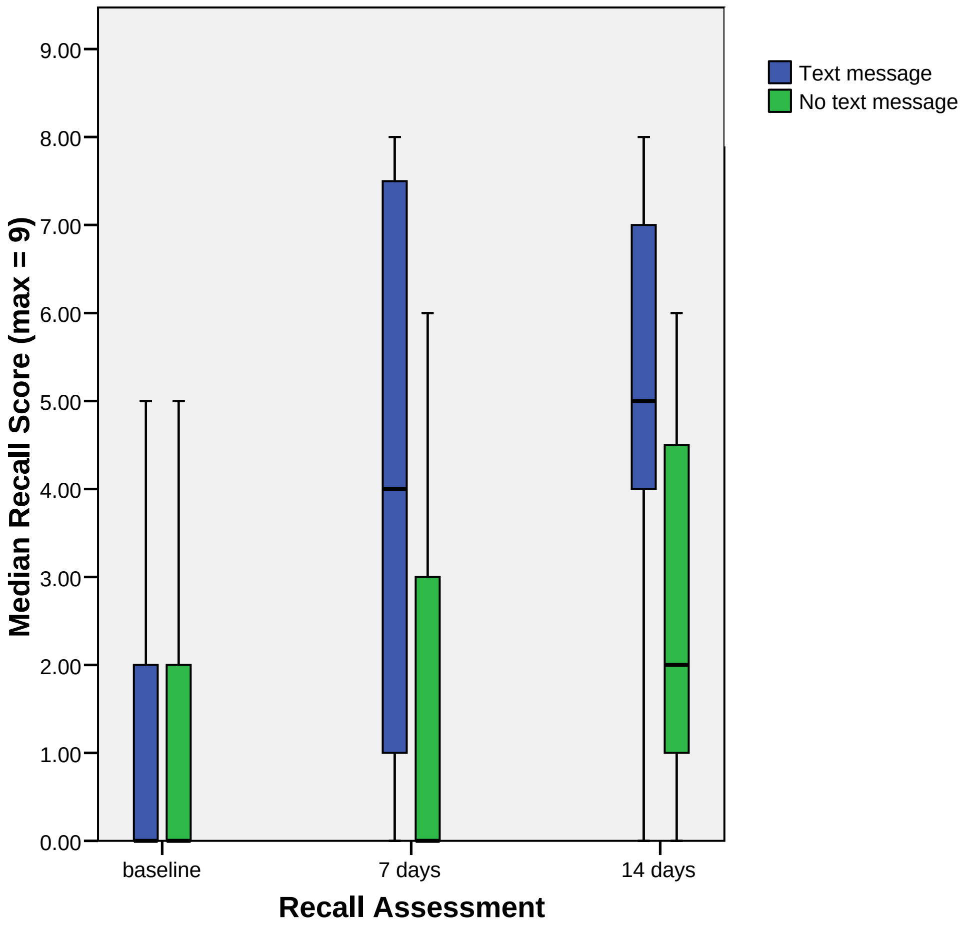
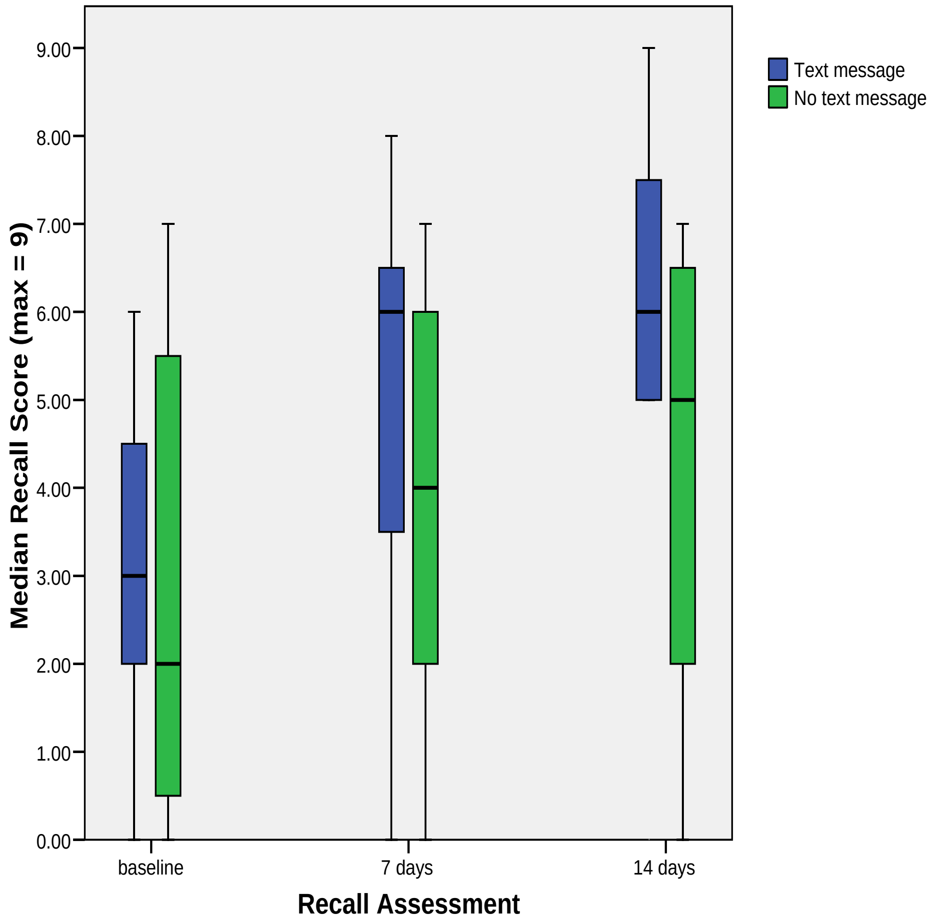


Figure 1.2: Boxplot showing the cued recall medians and interquartile ranges for text and no text conditions at baseline, 7 days and 14 days.



Chapter Three: Advanced Clinical Practice I Reflective Critical Account

Reflections on working with severe and enduring mental health problems

Submitted in Partial Fulfilment of the Requirements of the Degree of Doctorate in Clinical Psychology

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Abstract

This reflective account details my initial anxieties about working with those who suffer severe and enduring mental health problems. Discussed with reference to Gibbs' (1988) model, this account describes the process of reflection through which a greater understanding of my professional practice was made. The account chronicles my underlying views of severe and enduring mental health difficulties and how recent experiences working in this area changed these views and brought about gains in my personal and professional development. The wide reaching implications of this new learning are discussed in relation to Individual Learning Outcomes and National Occupational Standards for Psychology.

Chapter Four: Advanced Clinical Practice II Reflective Critical Account

Reflections on Service Development

Submitted in Partial Fulfilment of the Requirements of the Degree of Doctorate in Clinical Psychology

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Abstract

This reflective account details recent experiences relating to service development. Discussed with reference to Gibbs' (1988) model, the account draws on recent experiences with my future colleagues in a physically disabled rehabilitation service who identified me as a champion of service development. While service development is identified as a key role in the British Psychological Societies National Occupational Standards (NOS) for psychologists, it was an area that received little attention throughout my clinical training. My initial reactions to issues pertaining to service development are discussed, as are the benefits I derived through the reflective process.

Appendix 1

Authors notes for Neuropsychological Rehabilitation

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- Neuropsychological Rehabilitation

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Appendix 2.1

Major Research Project - Proposal

Abstract

A single-blind within-subjects trial is proposed to test the efficacy of sending SMS text messages to patients with a traumatic brain injury as a means of improving their recall of rehabilitation goals. Approximately 26 participants will be recruited from a community treatment centre for brain injury and will be sent text messages relating to three randomly selected goals from a selection of six current goals three times per day for fourteen days. Participants' recall of their rehabilitation goals will be assessed at baseline, seven days, and fourteen days via free recall and cued recall procedures. Data will be analysed in accordance with their distribution.

Key Words: Prosthetic memory aids; Traumatic brain injury; Rehabilitation goals

Introduction

Neuropsychological rehabilitation can be described as ‘any intervention strategy or technique which enables patients and their families or carers to live with, manage, by-pass, reduce or come to terms with cognitive deficits precipitated by injury to the brain’ (Wilson, 1989 p. 117). Over recent years, the process of identifying and setting goals has become a defining feature of neuropsychological rehabilitation. At the heart of goal setting is the premise that by setting goals one is able to bring about a larger behavioural change in the patient, reducing disability and optimising quality of life.

Despite widespread use of goal setting there has been limited research examining the specific impact of such procedures in rehabilitation services (Wade, 1998). A recent systematic review concluded that empirical evidence regarding the effectiveness of goal planning was ‘inconsistent and compromised by methodological limitations’ (Levack et al., 2006, p. 739). Another review concluded that there is some empirical support for goal setting, but that further work needs to be carried out to establish its reliability and sensitivity (Hurn, Kneebone, & Cropley, 2006). Similarly, there is a dearth of research examining critical components of goal setting or examining the impact of manipulations to goal setting procedures. Outwith rehabilitation settings there is a much larger evidence base in relation to the effectiveness of goal setting and the impact of manipulations of specific components of the process. Goal setting theory has a long history within the organisational literature and Locke and Latham (2002) pull together a large body of evidence that illustrates the wide reaching effects and benefits of goal setting. They forward a model in which an effective goal is based on how specific and difficult the goal is. This stems from the reliable finding that difficult and specific goals lead to higher levels of performance than do easy or vague goals (Locke, Saari, Shaw, & Latham, 1981).

Goals are thought to serve a directive function, focusing attention and effort toward goal relevant activities; they energise performance and by setting goals people will tend to persist more with a given task (LaPorte & Nath, 1976). Furthermore, goals affect action indirectly by leading to the discovery and use of task relevant knowledge and strategies (Wood & Locke, 1990). When presented with a goal, people automatically use existing relevant knowledge and skills to aid the attainment of that goal (Latham & Kinne, 1974), draw on past experiences and problem solving skills (Latham & Baldes, 1975), and engage in deliberate planning to develop strategies to assist in the achievement in novel goals (Smith, Locke, & Barry, 1990). However, some of these steps may be compromised by the nature of the brain injury e.g. impaired problem solving or planning abilities.

One of the most robust findings within the goal theory literature is that the goal performance relationship is strongest when people are committed to their goals, particularly when goal difficulty is high (Klein, Wesson, Hollenbeck, & Alge, 1999). Goal commitment is affected by the importance of the goal and the person’s sense of self efficacy - their belief that the goal is achievable. Generally, the more important a goal is to an individual the more motivated they will be to achieve it. A further moderator of goal performance is task complexity. As the complexity of a task increases so to does the need for higher skill levels and the successful attainment of that goal rests on ones ability to develop and implement novel task strategies. The use of proximal goals has also been shown to facilitate goal achievement (Bandura & Cervone, 1983; Becker, 1987) with Frese and Zapf (1994) arguing that proximal goals provide greater feedback which allows participants to accurately align their performance with their goal.

Goal setting has been used extensively in organisational settings as a means of improving performance and has been adopted by rehabilitation services throughout the world. McMillan and Sparkes (1999) report that goal setting has contributed to meaningful treatment effects in several patient populations including adults with acquired brain injury (Ward & McIntosh, 1993); psychiatric patients (Houts & Scott, 1975); older adults (Barraclough & Flemming, 1986); people with spinal injuries (Kennedy, Walker, & Whute, 1991); learning difficulties (Fuchs & Fuchs, 1986); and sports injuries (Theodorakis, Beneca, Malliou, & Goudas, 1997).

Within the neurorehabilitation setting, McMillan and Sparkes (1999) suggest that not only does the setting of specific, difficult goals lead to improved performance but goals also provide a meaningful outcome measure for health services. They recommend that both short-term (proximal) and long-term (distal) goals should be set with all goals being client centred, realistic and attainable during admission within the rehabilitation setting. Goals should be clear and specific, have a definite time deadline and must be measurable. While setting specific challenging goals maximises performance (Locke, Sari, Shaw, &

Latham, 1981), it may also have the consequence of some goals not being met as was the case in McMillan and Sparkes review of a brain injury rehabilitation service in which 22% of distal goals were not achieved.

Survivors of a brain injury often have difficulty in formulating and implementing relevant treatment goals (Gauggel, Konrad, Wietasch, 1998). As a consequence there is often the temptation for rehabilitation professionals to assign goals to the patient without their active involvement (Ben-Yishay & Prigatano, 1990). Hollenback and Brief (1987) suggest that the primary influence of assigned goals is that they are assured to be specific and challenging and there is evidence that self-set goals tend to be less challenging than assigned goals (Locke & Latham, 1990).

Impairments in memory, attention and executive functioning are common after brain injury. Patients are thus vulnerable to forgetting to carry out intended actions (prospective remembering) either because they forget the content of the intention (what it is that should be done) or forget to carry out the action at the appropriate time. Similarly, patients may find it difficult to recollect goals set for rehabilitation and hence be less likely to carry out the actions towards achieving those goals.

With respect to rehabilitation interventions aimed at improving prospective remembering, the majority of research has focused on compensatory strategies. Initially this meant ‘paper and pencil’ methods such as notebooks or planners (Wilson, 2000; Sohlberg & Mateer, 1989). However, as technology becomes more accessible and smaller in size, so its application within the brain injury setting has grown. Over the last ten years there has been a growing body of research documenting the effectiveness numerous ‘cognitive prostheses’ including personal digital assistants (Bergman, 2002), paging systems (Hersh & Treadgold, 1994; Wilson, Emslie, Quirk, & Evans, 2001); voice recorders (Hart, Hawkey, & Whyte, 2002) and mobile phones (Wade & Troy, 2001; Fish et al., 2006; Pijnenborg, Bosch, Evans, & Brouwer, in press).

Only one study has examined an intervention aimed at improving the ability of people with acquired brain injury to remember rehabilitation goals. Hart et al. (2002) demonstrated that a portable voice organizer could be used to help people with a traumatic brain injury recall their therapy goals. The voice organiser alerted the participants three times per day by beeping which served as a prompt to attend to a recorded message of their goals. At follow-up, results showed that recorded goals were more easily recalled than unrecorded goals.

In recent years the number of people who use mobile phones and in particular use SMS text messaging has increased dramatically. This means that many of the people who have a brain injury now are familiar with this form of communication. Recent studies have suggested that text messaging may improve prospective memory for specified actions (Fish et al., 2006; Pijbenborg et al., in press). The aim of the present study is to investigate whether SMS text messaging is an effective tool for increasing recall of rehabilitation goals in a group of patients who are engaged in rehabilitation after brain injury.

Aims and Hypotheses

Aims

This study aims to improve the recall of therapy goals in those participating in a brain injury rehabilitation programme by sending them reminding SMS text messages.

Hypotheses

It was hypothesised that participants' would show improved free- and cued-recall for those goals for which text reminders were provided as compared to those goals for which no reminders were provided.

Plan of Investigation

Participants and Recruitment

Participants will be recruited from a community treatment centre for brain injury rehabilitation in the West of Scotland. The treatment centre is a post-acute rehabilitation facility for people with acquired brain injury and provides short-term, goal orientated therapies. Approximately twenty-six participants will be recruited from the service (see subsequent section for justification of sample size). Around eight people are discharged per month with new patients being taken on when resources permit. It is thought that most patients attending the centre will be suitable candidates of the study. Discussions with staff members suggest that the predicted sample size would be able to be sampled within an appropriate time frame of around six to eight months.

Potential participants would be identified by the clinical service manager at The Community Treatment Centre for Brain Injury. Only those deemed by the Clinical Service Manager to meet the inclusion and exclusion criteria would be offered the opportunity to participate in the study. Potential participants would be invited to participate in the study via an invitation to participate letter. The letter would be addressed to the patient and would come from, and be signed by, the Clinical Service Manager. The letter would note that the centre is working together with the University of Glasgow and explain the project. The letter would make it clear in the usual way that there was no obligation for participants to take part and that not taking part would not affect the service they received from the centre in any way. The contact details of the lead researcher will be included so the participant may ask any questions they have regarding the study, and the participant would also be informed that they could also ask the member of the clinical team for general information about the project. Team members would be briefed on the project, but also trained in the importance of avoiding any coercion of patients to participate in research. The participant would be invited to return the free post reply form if they wished to participate.

It is commonly reported that recruitment of brain injured participants suffers poor rates of recruitment because many potential participants forget to return the response sheet. In an effort to address this issue, it is proposed that when potential participants attend for their routine clinical session at the community treatment centre they are handed a flyer which will remind them of the project they have been invited to participate in. The flyer will prompt them to note their interest with a member of the clinical team if they wish to participate who will then pass their details to the researcher. Additionally, it will identify who they may contact for further information and clearly states there will be no adverse effects on their routine treatment if they do not wish to participate.

Inclusion and Exclusion Criteria

Inclusion criteria will include: 1) acquired brain injury 2) the documentation or clinical observation of the presence of a memory deficit 3) active participation with the rehabilitation programme 4) participants having at least six therapy goals set as part of their rehabilitation programme 5) are at least three months post injury and 6) own their own mobile phone. Exclusion criteria will apply to those who: 1) Display severe receptive or expressive language difficulties 2) are unable to reliably access text messages on their mobile phone 3) have difficulties with aggression 4) have consistently failed to attend their appointments at the treatment centre and 5) are under the Adults with Incapacity (Scotland) Act (2000) or are otherwise not able to provide informed consent.

Design & Procedure

The study will be a prospective, within subjects' trial. Twenty-six participants will be recruited and set goals in keeping with their participation at the community treatment centre for brain injury rehabilitation. From a selection of six goals, three will be randomly selected and sent to the participant each day via SMS text message over a two week period. Prompt words will be associated with the goals. Both free and cued recall will be assessed for all six goals at the end of week one and week two of the trial.

Patient's goals will typically consist of concrete proximal and distal goals. Within this particular West of Scotland population, goals tend to be focused around activities of daily living, leisure pursuits and work. Goals are created in partnership with the participant who will be expected to work towards achieving these goals during the course of their rehabilitation. Goals are normally expressed at a level that the patient understands and should be expressible in a single sentence. Each therapist with whom the participant is involved will be asked to contribute to a list of goals which reflect the current rehabilitation needs of the participant. Along with this list of goals, 'prompt' words will be agreed between the goal setting clinician and the participant. These will be subsequently used as part of a cued recall procedure. For example, the word 'initiate' may represent the broader goal of 'the participant will initiate a conversation with the therapist at the beginning of each therapy session'.

From the list of all the goals the participant is working towards, six will randomly be selected to be involved in the trial. From these six goals, three goals will randomly be assigned to the intervention condition (being sent to the participant via SMS text message) and three to the treatment as usual condition. Six indistinguishable envelopes containing the numbers one to six will be shuffled and the participant was asked to select three envelopes. The three selected goals will then be entered on to an online text messaging service called textanywhere.net. The staff at the rehabilitation centre will be blind to which are the intervention goals and which are the treatment as usual goals. Once the goals and prompt words have been identified, the researcher will meet with the participant. Participants will be sent a text message within the initial session and asked to access and read the message so that their competency using a mobile phone can be assessed. Participants will then be asked to recall as much as they can remember about their goals in both a free recall and cued recall procedure. This assessment procedure will be repeated at 7 days and 14 days after the baseline assessment. Cued recall will be assessed by providing the participant with the cue word that had previously been associated with each of their therapy goals. Feedback will not be provided regarding the accuracy of their recall.

Using a similar methodology as used by Hart, Hawkey, and Whyte (2002), participants will be awarded points on the basis of their recall accuracy. Three points will be awarded if the response mirrors the original goal statement in terms of ideas and accuracy of content. Two points will be awarded if the participant can recall the general theme but is unable to provide specific details and their answer may show evidence of intrusions or distortions. One point will be awarded if the participant's recall suggests a basic awareness of the goal but the response is likely to have significant distortions and be lacking in specific details. A score of zero will be awarded if the participant provides a "don't know" response or their recall does not reflect the goal in any way at all. The researcher will record the participant's responses on a tape recorder. Participants' responses will be scored blindly by a clinician not associated with the research. A scoring guide with examples will be made available.

Justification of Sample Size

Analysis of similar studies (e.g. Hart et al., 2002) show large effect sizes although the size of this effect may be misleading given that the data was not normally distributed and floor effects were in operation. As such, a more conservative estimate of effect size of 0.8 will be adopted for this study. Thus, a sample size of around 26 participants will be required to find the predicted large effect.

Settings and equipment

The study will be run within a community treatment centre for brain injury rehabilitation in the West of Scotland. Prior arrangements have been made so that a suitable clinical space will be available for the researcher to see participants. Participants will be required to use their own mobile phones for the duration of the trial. They will be sent text messages from the researcher through a web based text message service (textanywhere.net). This service has been used in previous research trials and has been found to be a reliable and time efficient way of managing such operations.

Data analysis

Data analysis is dependant on the distribution of the data obtained. It is proposed that data may be analysed by a 2 (text vs. no text) X 2 (free recall vs. cued recall) x 3 (baseline vs 7 days vs 14 days) ANOVA if it appears to be normally distributed. However, the analyses from other studies similar to this current one have had to rely on Friedman nonparametric repeated measures analysis of variance by ranks as the data did not follow a normal curve. Using such methods will not impact on the scientific integrity of the results.

Health and Safety

Health and safety issues will be discussed with the field supervisor prior to the recruitment of participants. As discussed above, those with significant difficulties managing aggressive behaviour will be excluded from the study. The clinical room will have a panic alarm and while the researcher will work on an individual basis with participants, they will not be working in the building alone or outside of normal working hours.

Ethical Issues

The primary ethical issues relate to the degree to which some participants may give informed consent to take part in the study. Only those who, in the judgement of the Community Treatment Centre Clinical Director, have the capacity to give informed consent will be invited to participate. There is likely to be a minimal disruption to the participant's daily lives as receiving a text message is a fairly common experience.

Financial Issues

There is likely to be a cost of around £120 associated with this study. Approximately £110 of this will cover the cost of sending text messages to the participants. This is calculation is based on twenty-six participants receiving three texts per day for fourteen days at a standard text cost of ten pence. The balance of the cost will cover stationary such as paper and free post envelopes.

Timetable

The duration of the study is reliant on the recruitment rate of participants. The proposed timetable for his study will be around one-year. It is hoped that recruitment may begin in September 2007 and run for around six to eight months.

Practical Applications

The number of people who use mobile phones and in particular use SMS text messaging has increased dramatically in the last ten years and this trend is likely to continue. This means that both the current and future brain injured populations will be familiar with this form of communication. If the use of SMS text messages are helpful in increasing recall of therapy goals, it would then be possible to justify using this method of reminding more broadly in the rehabilitation field. Positive results would also allow further studies to be conducted examining the relationship between improved recall of therapy goals and positive goal orientated behaviour and attainment.

Ethical and management Approval Submission

Ethical approval for this single centre study will be sought from the NHS Greater Glasgow Primary Care Division Local Research Ethics Committee 1. Research and development approval will be sought simultaneously with the ethics proposal and will be made to the NHS Greater Glasgow Primary Care Division.

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Appendix 2.2

Participant Information Sheet

Section of Psychological Medicine, University of Glasgow
Community Treatment Centre for Brain Injury, Glasgow
Central Scotland Brain Injury Rehabilitation Centre

UNIVERSITY of GLASGOW

Rehabilitation Goals Memory Study

INFORMATION SHEET

Who is conducting the research?

The research is being carried out by Professor Jonathan Evans and Mr Campbell Culley from the Section of Psychological Medicine of the University of Glasgow. It is being carried out in the Community Treatment Centre for Brain Injury in Glasgow and the Central Scotland Brain Injury Rehabilitation Centre in near Wishaw.

What is the research about?

Following brain injury it is common for people to receive rehabilitation. There is evidence that suggests rehabilitation is most successful when people work towards achieving goals e.g. getting back to work or being able to climb the stairs again. Following a brain injury many people experience memory difficulties and find it helpful to use memory strategies such as notebooks or diaries. Previous research has shown that text messages sent to people's mobile phones can also be effective at reminding people of things. This study is hoping to increase the amount of information people can remember about their rehabilitation goals. The researchers believe they will be able to help people remember more about their goals by sending them text message reminders to their mobile phones.

What does taking part involve?

If you decide to take part you will meet with the lead researcher to discuss the project and the various rehabilitation goals that you are working on. We will pick out six rehabilitation goals to be included in the project. Reminders of your goals will then be sent to your mobile phone by text message. You will receive three text messages each day for two weeks. In order to see if the text messages are helping you remember your goals, we need you to take part in some simple memory tests. The memory tests will involve the researcher asking you what your goals are. The meetings would take place in the rehabilitation centre and would be completed 7 days and 14 days after you begin the project. In total, you would meet with the researcher on three occasions during the project for around thirty minutes. Appointments can be arranged to follow from existing appointments within the rehabilitation centre or at your convenience.

Does the research involve any medical examination or medication?

No.

What happens to the information?

The information from your memory scores are kept in strict confidence within the study team. The data are held in accordance with the Data Protection Act which means that we keep it safely and cannot reveal it to other people – even the clinical team – without your permission. If we publish any findings from the study, your results would be combined with those of many other people and *average* scores are presented. We take very special care not to publish any details that could lead an individual to be identified. If you would like to see an example of the form in which results are published, please just ask a member of the study team.

What if I don’t want to take part?

Whether or not to take part is entirely up to you. Whilst our research relies on the help of volunteers we quite understand that there may be many reasons not to take part. You do not need to give a reason and we completely respect that decision. This project is completely separate from any clinical services you may be receiving and your decision has no effect on your access to these services.

If I agree to take part and then change my mind?

You can withdraw from the study at any stage without having to give a reason.

Will taking part have any advantages for me?

It is hoped that receiving text messages reminding you of your rehabilitation goals will improve your memory for your goals. This may have other benefits such as encouraging some people to think more about their goals and may result in increased rates of goals being achieved. Furthermore, if it is clear that your mobile phone is a useful memory strategy for you, with your permission, we can discuss ways to incorporate this into your rehabilitation programme.

Who is funding the research?

This research is being funded by The Department of Psychological Medicine at The University of Glasgow.

Who has reviewed the study?

This study has been reviewed by the NHS Greater Glasgow Primary Care Division Local Research Ethics Committee.

If I have any further questions?

We will give you a copy of this information sheet and the signed consent form to keep, but if you would like more information before you decide whether or not to take part, please ask a member of the project team.

Who should I contact?

The project team are:

Campbell Culley, Trainee Clinical Psychologist, Community Treatment Centre for Brain Injury, 70 Commercial Road, Gorbals, Glasgow G5 0QZ.

Tel: 0141 300 6313

Email: 9804006c@student.gla.ac.uk

Professor Jonathan Evans, Professor of Applied Neuropsychology, Section of Psychological Medicine, Gartnavel Royal Hospital, 1055 Great Western Road, Glasgow, G21 0XH.

Tel: 0141 211 3978

E-mail: jonathan.evans@clinmed.gla.ac.uk

Caroline Davidson, Acting Clinical Director, Community Treatment Centre for Brain Injury, 70 Commercial Road, Gorbals, Glasgow G5 0QZ

Tel: 0141 300 6313

Email: Caroline.Davidson@glacomen.scot.nhs.uk

Ann Hunter, Manager, Central Scotland Brain Injury Rehabilitation Centre, Murduston Castle, Wishaw, Bonkle.ML2 9BY

Tel: 01698 384 055

Email: central.scotland@fshc.co.uk

If I have a complaint about any aspect of the project?

If you are unhappy with any aspect of your participation in the project, please first contact Professor Jonathan Evans, who is the principle investigator for the project.

Should any complaint not be resolved satisfactorily, you can contact: Mr Brian Rae, Research Manager for NHS Greater Glasgow Primary Care Division (R&D Directorate), Gartnavel Royal Hospital, 1055 Great Western Road, Glasgow, G12 0XH.

Tel: 0141 211 0284

E-mail: brian.rae@glacomen.scot.nhs.uk

Appendix 2.3

Participant Consent Form

Section of Psychological Medicine, University of Glasgow
Community Treatment Centre for Brain Injury, Glasgow
Central Scotland Brain Injury Rehabilitation Centre

UNIVERSITY of GLASGOW

Rehabilitation Goals Memory Study

CONSENT FORM

Please initial box

I confirm that I have read and understand the information sheet dated 17/07/07 (Version 1) for the above study and have had the opportunity to ask questions

I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected.

I understand that sections of my medical notes may be looked at by the research team where it is relevant to my taking part in the research. I give my permission for the research team to have access to my records.

I give my permission for my GP to be informed that I am taking part in the Rehabilitation Goals Memory Study**.**

I agree to take part in the Rehabilitation Goals Memory Study.

Name of participant	**Date**	**Signature**
Name of researcher	**Date**	**Signature**

Appendix 2.4

Rehabilitation Goals Scoring Criteria

Points	Description	Examples Goal Statement	 Participant Recall
3	The response closely captures the original goal statement, including main ideas and accurate details.	To use right hand as an assistor during meal prep sessions.	I've to use my right hand as an assistor during meal prep.
2	Most of the statement has been retained, some details may be missing or contain minor distortions.	To carry a bag containing a diary, phone, and pen, 70% of the time	To make sure I've got my bag on me with my phone and diary in it.
1	The topic was recognisable but recall was vague or lacking in detail. The main topic may be significantly distorted.	To walk to the gate and back with supervision 3x per week	Walking
0	Recall of information not related in any way to the goal, no recall of the goal, or 'don't know' responses.	To keep written notes when in important meetings	Get a prospectus for the collage.

Table 1. Results summary of computerised memory rehabilitation studies

Author	Type	Number	Chronicity	Severity	Assessment Measures	Intervention	Primary Results
Dou et al. (2006)	RCT	T1 = 13 T2 = 11 C = 13	3 months +	Not specified	Neurobehavioral Cognitive Status Examination (NCSE); the Rivermead Behavioural Memory Test (RBMT) - Cantonese version; Hong-Kong List Learning Test (HKLLT). Follow-up at 1 month.	Approximately 15 hours of computerised memory training containing basic memory tasks, working and semantic memory, mnemonic exercises, and application to real life situations. Intervention administered by computer (T1) or therapist (T2). Controls received no specific memory rehabilitation.	Significant improvements in T1, T2, and control groups on the NCSE. Pre- and post-training scores showed significant improvements on the RBMT for T1 and T2 Vs Control. T1 showed improved encoding, storage, and retrieval on the HKLLT Vs T2 and controls. No significant difference between post-training outcome measures at 1-month follow-up.
Tam & Man (2004)	RCT	T1 = 6 T2 = 6 T3 = 6 T4 = 6 C = 8	3 months +	RBMT < 15/24	RBMT and computerised training measures.	Ten, 20-30 minute computer sessions that increased in difficulty. Computerised memory program focused on self-paced (T1), feedback (T2), personalised (T3), and visual presentation (T4). Modules on faces & names, prospective memory, retention of verbal information, and recall of locations. Controls received no specific memory rehabilitation.	Significant improvement in the 'drilled content' of the training programme, particularly for the 'feedback' group. No improvement on RBMT for any treatment group.
Goldstein et al. (1996)	Non-RCT	T = 10 C = 10	1 year +	Serious	WAIS/WAIS-R, WMS/WMS-R, Mattis Dementia Rating Scale. Outcome also measured on training stimuli.	Computerised memory training of two visual imagery based techniques for improving memory over 15 sessions, carried out 2-3 times per week. Controls formed from an earlier study (Goldstein et al., 1988)	No significant advantage of computerised methods over non-computerised methods for verbal-recall. Computerised Intervention significantly better on face-name learning.

T= Treatment Group; T1 = Treatment Group 1; T2 = Treatment Group 2; T3 = Treatment Group 3; T4 = Treatment Group 4; C = Control Group.

Table 1. Results summary of computerised memory rehabilitation studies

Author	Type	Number	Chronicity	Severity	Assessment Measures	Intervention	Primary Results
Ruff et al. (1994)	Non-RCT	T1 = 7 T2 = 8 C = 0	6 months +	Severe	Neuropsychological test measures: Selective Attention Test, Digit Symbol, Continuous Performance Test, Rey Auditory Verbal Learning Test, & the Corsi Block Learning Test; THINKable assessments regarding memory and attention; Behavioural Assessments – patient & observers self-rating scales	Up to 20 hours on THNIKable – memory and attention rehabilitation. T1 received attention training then memory training, T2 received memory training then attention training.	Improvements on some aspects of attention and memory as measured by the computerised tasks. Significant gains on digit symbol, logical memory, verbal, & visuospatial learning tasks. Observers rating scale suggests improvements in attention and memory. Pre- and post- comparisons show significant improvements on Mental Control and Logical Memory.
Towle et al. (1988)	Quasi-Experimental	T1 = 11 C = 0	3-36 months	Stroke	Frenchay Activities Index, Mini-Mental Status Examination, Boston Diagnostic Aphasia Examination, Wakefield Depression Inventory, NART, Recognition Memory Test for Words, RBMT.	Computer games designed to retrain memory (pictures, words, face recognition, word list recall, and memory for a map) for 40 minutes, for a maximum of four times per week for six weeks.	Significant improvements on immediate prose recall.
Marks et al. (1986)	Non-RCT	T = 10 C = 10	Not specified	Not specified	Wechsler Memory Scale, Symptom Checklist	Home-based computerised memory rehabilitation addressing perceptual grouping, mental imagery, verbal mediation, and other mnemonic strategies.	Significant improvements on the WMS memory quotient post –treatment and gains maintained at 6-12 month follow-up.
Kerner & Acker (1985)	RCT	T = 12 C1 = 6 C2 = 6	3 months +	Mild – severe	New York University Memory Test (NYUMT).	T received 9 hours (12, 45-minute sessions over a period of four and a half weeks) of memory re-training. C1 received an equal amount of computer exposure to complete pictures and other graphics tasks. C2 received no treatment and had no exposure to the computer.	Significant gains made by T on recall scores on the memory-training package. T1 and both control groups improved on NYUMT. T1 showed sig. improvement on acquisition/recall over controls. No support for maintained gains of T1 at 15 day follow-up.

T = Treatment Group; T1 = Treatment Group 1; T2 = Treatment Group 2; C = Control Group; C1 = Control Group 1; C2 = Control Group 2.

Table 1. Results summary of computerised cognitive (memory) rehabilitation studies

Author	Type	Number	Chronicity	Severity	Assessment	Intervention	Primary Results
Chen et al. (1996)	Archival Non-RCT	T = 20 C = 20	T = 16 months C = 6.8 months	T coma length = 24 days C coma days = 11 days	WAIS-R, parts of the WMS including digit span, mental control, logical memory (immediate and delay) visual reproduction (immediate and delay) and paired associates (immediate and delay). Additionally, the category test, trail-making test A & B and the Wisconsin Card Sorting test.	Hierarchical based computer-assisted cognitive rehabilitation programme addressing attention, visuospatial abilities, memory, and problem solving. Controls received other therapies including speech therapy and occupational therapy.	Treatment group made significant improvements on 15 neuropsychological measures Vs. 7 significant gains by the control group. No significant differences between computerised methods and traditional rehabilitation as measured by neuropsychological test scores.
Giaquinto & Fori (1992)	Case series	T = 4 C = 0	Not documented	Severe-extremely severe	All Wechsler Adult Intelligence Scale subtests, PM 38, Wechsler Memory Scale, Rey Picture (copy & memory), Block tapping test, Toulouse-Pieron Test, Supraspan learning	Received between 20 and 120 hours of computerised cognitive training over a 4-24 week period focusing on attention, discrimination, memory, and sequencing.	Significant improvement on WMS measures, WAIS, PM38, and Supraspan Learning
Middleton et al. (1991)	Non-RCT	N = 36 N for T1 & T2 not specified C = 0	Mean = 3 years	Not specified	Digit span, Verbal Paired Associates, Knox's Cube, Block Counting, Concept Formation, and Shipley Abstraction.	96 hours of educational training as well as 32 hours of computer assisted treatment focusing on attention & memory or reasoning and logical thinking skills.	Significant improvement on digit span, verbal paired associates, and Knox's Cube. No differential effect shown by treatment condition.

T = Treatment Group 1; C = Control Group

Table 1. Results summary of computerised cognitive (memory) rehabilitation studies

Author	Type	Number	Chronicity	Severity	Assessment	Intervention	Primary Results
Ruff et al. (1989)	RCT	T = 20 C = 20	1-7 years	Serious	Galveston Orientation and Amnesia Test, Ruff language Screening Exam, Sensory Perceptual Examination, Mattis Dementia Rating Scale.	160 hours of computerised treatment over 8 weeks addressing attention, spatial integration, memory, and problem solving. Computer programme designed to provide visual and verbal stimuli to which mnemonic methods could be applied. Controls received computer and video games, coping skills, health & well being discussions, independent living tasks, and art.	Both T1 & Control showed significant gains on neuropsychological performance. T1 showed improved verbal encoding and reduced errors on visual selective attention.
Batchelor et al. (1988)	Non-RCT	T=17 C=17	T = 73 days C = 96 days	Severe-extremely severe	Wechsler Adult Intelligence Scale-Revised; Wechsler Memory; Selective Reminding Test; Paced Auditory Serial Addition Task.	20 hours of computerised therapy over 4-6 weeks addressing recent memory, attention, speed of information processing, higher cog functioning. Controls received mnemonic strategy training and activities to promote planning and organising.	Both T1 & Control showed a significant improvement on all measures of neuropsychological function at follow-up. No significant benefit of T1 Vs Control in terms of neuropsychological outcome. T1 showed improvements in verbal encoding and fewer errors on visual memory.

T = Treatment Group 1; C = Control Group