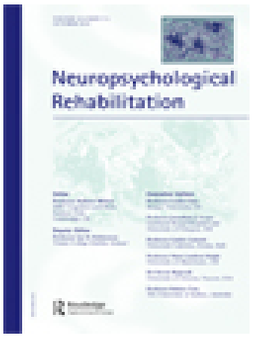

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Do memory aids help everyday memory? A controlled trial of a Memory Aids Service

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ABSTRACT

There is a growing body of knowledge about the use of compensatory memory aids in memory rehabilitation, but relatively few controlled trials on how to train the use of such aids. This study investigated the effects of systematic training in the use of compensatory memory aids on everyday memory functioning within a Memory Aids Service. In a controlled clinical trial, a comparison was made between treatment participants and waiting list controls. Participants had everyday memory problems secondary to progressive or non-progressive neurological conditions. Following baseline assessment and goal setting, treatment participants underwent three training sessions, in which memory aids were matched to goals, across a six week period, with a follow-up assessment 12 weeks later. Outcome was measured by a goal attainment diary, neuropsychological test performance, psychosocial questionnaires and a problem solving inventory. There was a significant treatment effect of training on the goal attainment diary but only at 12 weeks follow-up. A post-hoc analysis indicated that treatment was effective for participants with a non-progressive condition but not for participants with a progressive condition. We conclude that a Memory Aids Service can be beneficial for patients with a non-progressive neurological condition, and make suggestions that might inform future applications of memory aids with those who have a progressive neurological disorder.

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KEYWORDS Memory; rehabilitation; compensatory aid; training

Introduction

Compensatory rehabilitation approaches to memory impairment seek to bypass the deficit and teach the individual how to use certain strategies to solve functional problems (Kapur & Wilson, 2009). External memory aids are the most effective and widely used intervention for the rehabilitation of memory impairments (Sohlberg et al., 2007). An external memory aid is a tool or device that "either limits the demands on the person's impaired ability or transforms the task or environment such that it matches the client's abilities" (Sohlberg, 2006, p. 51). Neuropsychological

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rehabilitation has a long history in the use of so called "low technology" compensatory memory aids such as stationery-based aids including notebooks, diaries and calendars. There is a rapidly growing market of high technology, electronic memory aids, such as calendars operated on a personal computer, smart phones, voice recorders, and paging devices. However, both low technology and high technology memory aids may be difficult for people with cognitive impairments to learn how to use. Whilst there is growing evidence of the effectiveness of the use of memory aids, there have been relatively few controlled trials of interventions that incorporate systematic training in their use.

There is a growing evidence base for the effectiveness of individual aids to rehabilitate acquired memory disorders. The use of memory notebooks to support prospective memory and memory for past events has been studied extensively (see Ownsworth & Mcfarland, 1999; Sohlberg & Mateer, 1989). Shum, Fleming, Gill, Gullo, and Strong (2011) conducted a randomised controlled trial of self-awareness training and diary use with positive effects on personal prospective memory tasks. Compelling evidence comes from a series of studies using the Neuropage system to target specific everyday functional goals (Wilson, Evans, Emslie, & Malinek, 1997; Wilson, Scott, Evans, & Emslie, 2003; Martin-saez, Deakins, Winson, Watson, & Wilson, 2011). After selection of target behaviours, such as remembering to take medication or attendance at appointments, participants were provided with a pager and then sent reminders for these behaviours at times agreed with the participants and their carers. With a sample of 143 participants, use of the pager significantly increased performance of target behaviours relative to baseline (Wilson et al., 1997, 2003). Whilst early studies showed promise for the use of portable electronic organisers (Giles & Shore, 1989; Kim, Burke, Dowds, Boone, & Park, 2000) and personal digital assistants (PDAs; Gentry, Wallace, Kvarfordt, & Lynch, 2008; Wright et al., 2001), these devices have been superseded by the relentless advance of smart phone technology which encompasses PDA technology within a mobile phone. Initial studies supported the use of mobile phones as reminding devices (Stapleton, Adams, & Atterton, 2007; Wade & Troy, 2001) and to help with difficulties in organisation and initiation (Fish, Manly, & Wilson, 2008). More recently, Svoboda, Richards, Leach, and Mertens (2012) were successful in training individuals with moderate to severe memory problems in the use of a calendar function on a smart phone, with successful generalisation.

Memory aids have also been used to support the everyday memory function of individuals with a progressive neurological disorder such as Alzheimer's disease or mild cognitive impairment (MCI; Clare, 2008). Memory aids have been integrated into general memory rehabilitation programmes for people with dementia with increased attainment of everyday memory goals (Clare et al., 2010) and prospective memory performance (Kinsella et al., 2009). Troyer, Murphy, Anderson, Moscovitch, and Craik (2008) demonstrated the effectiveness of a 10-session group intervention to increase awareness and use of memory strategies in people with MCI. Memory books and diaries have been used to support the memory function of people with early dementia or MCI (Greenaway, Hanna, Lepore, & Smith, 2008; Greenaway, Duncan, & Smith, 2012; Schmitter-Edgecombe, Howard, Pavawalla, Howell, & Rueda, 2008). Clare et al. (2000) described a case study in which a prompting and fading technique was used to teach a woman with early dementia to use a calendar and a memory board as an alternative to repetitive questioning of the carer, with significant reduction in repetitive questioning and evidence of generalisation. Individuals with progressive neurological conditions have also been trained in the use of more technological memory aids,

although studies have focused on aids that require minimal interaction from the user, such as in the Enable project (Duff & Dolphin, 2007) or Smart Home technology (e.g., Evans, Carey-Smith, & Orpwood, 2011).

The use of memory aids to compensate for acquired memory impairments is problematic for those people who need them most because of their cognitive impairments, and there is a need for details of the training procedures required to implement memory aids and so improve everyday functioning. Sohlberg and Mateer (1989) developed one of the first systematic training modules for use of a memory notebook. Training started with an initial acquisition phase, in which the subject was familiarised with each section of the notebook; an application phase in which the subject learnt when and where to use the notebook; and a final adaptation phase, in which use of the memory aid was modified and adapted to novel situations. Sohlberg and Tursktra (2011) have extended this approach to neurorehabilitation with the "PIE" approach of Planning, Intervention and Evaluation of outcome. The first stage of training requires careful planning to identify the key learner characteristics, to define the treatment target, specify the desired outcome, and design the treatment intervention. The Sohlberg and Mateer (1989) model is then encompassed in the following implementation phase which includes initial skill acquisition, then mastery and generalisation of the skill (which reflects the previous application and adaptation phases of training), prior to the maintenance of treatment results. Finally there is an evaluation of the clinical training intervention.

Wilson and Watson (1996) recommend that memory-impaired clients with additional cognitive impairments will need more intensive training to use compensatory aids, including errorless learning techniques, since people with severe explicit memory difficulties may not benefit from feedback in errorful learning protocols. Additional executive impairment has emerged as a barrier to long-term use of Neuropage (Emslie, Wilson, Quirk, Evans, & Watson, 2007; Fish, Manly, Emslie, Evans, & Wilson, 2008), arguing for adaptations to training programmes to take into account these additional cognitive impairments, although again this has not been systematically examined. Memory aids may need to be pre-programmed by the therapist for people with significant executive impairments (O'Connell, Mateer, & Kerns, 2003) and technological follow-up is recommended (Gilette & DePompei, 2004; Hart, Buchhofer, & Vaccaro, 2004; Wessels, Dijcks, Soede, Gelderblom, & DeWitte, 2003). A holistic approach to rehabilitation will take into account impaired awareness and client beliefs about rehabilitation, as individuals may not use a recommended memory aid if they believe that it will slow their recovery and make them less reliant on their own abilities (Baldwin, Powell, & Lorenc, 2011; Wilson & Watson, 1996). A client-centred approach with establishment of collaborative goals to motivate and energise the client is recommended (Hart & Evans, 2006) with matching of the memory aids to these goals (Gitlin, Schemm, Landsberg, & Burgh, 1996) and client involvement in the selection of the device to facilitate long-term use (Gitlin et al., 1996; Phillips & Zhao, 1993).

The current study aimed to evaluate the effectiveness of training in the use of memory aids on everyday memory function. A comparison was made between the effect of systematic training on everyday memory function in a treatment group and a waiting list control. Maintenance and generalisation of treatment were examined. The effectiveness of training for participants with a non-progressive or progressive neurological condition was also examined.

Method

The Memory Aids Service was established in November 2006 with funding from the Guys and St Thomas' Charity. The project was approved as a service evaluation by the South London and Maudsley Mental Health Trust National Division clinical governance meeting after a review by the chair of the Guy's and St Thomas' Local Research Ethics Committee. All participants were given written information regarding the study and gave written consent prior to the commencement of treatment.

The current study was a controlled clinical trial comparing the effect of treatment in the Memory Aids Service in a treatment group versus a waiting list control group. Participants were allocated to treatment or control groups, with every third referral allocated to the control group by the treating neuropsychologist (BKD).

Participants

Participants were referred to the Memory Aids clinical service on the basis of subjective reports of everyday memory problems as verified by the referring agent, neuropsychological assessment, or both. The clinic was established within the Neuropsychiatry and Memory Disorders service based at St Thomas' Hospital, London (Kopelman & Crawford, 1996). This service provides an outpatient specialist memory disorders service for people with memory complaints secondary to neurological disorders, possible early dementias, and memory complaints thought to have a psychological or psychiatric causation. Inclusion criteria were to have memory complaints secondary to a neurological disorder, progressive or non-progressive, and to have sufficient conversational English to understand assessment and rehabilitation procedures, and to give informed consent. Participants were not excluded on the basis of previous psychiatric history, neurological insult or drug and alcohol history and thus the final sample was a mixed neuropsychiatric group deemed to be representative of patients presenting to a standard memory clinic (see Kennedy & Turkstra, 2006).

Measures

Memory diary

Treatment outcome was measured by attainment of everyday memory goals. Goal attainment was measured with a daily record sheet, modelled on that used to evaluate Neuropage (Wilson et al., 2003). To determine overall goal attainment the number of "yes" responses was divided by the number of days that goal attainment was recorded for each goal (see Wilson et al., 2003).

Neuropsychological tests

To detail individual cognitive profiles and examine the influence of cognitive factors on treatment outcome the following tests were administered at baseline and follow-up:

- Premorbid function: The National Adult Reading Test–Revised (NART-R; Nelson & Willison, 1991) or Wechsler Test of Adult Reading UK (Wechsler, 2001) at baseline only. Participants assessed only in the Memory Aids Service were administered the NART-R.

- Intellectual Function: The two-subtest short form of the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999) of Matrix Reasoning and Vocabulary, at baseline only.
- Memory : The Rivermead Behavioural Memory Test–Extended (RBMT-E; Wilson et al., 1999) and the Cambridge Prospective Memory Test (CAMPROMPT; Wilson, Evans, et al., 2005). Version A was administered at the baseline assessment and Version B at the follow-up assessment.
- Information processing: Letter Number Sequencing and Digit Span subtests from the Wechsler Adult Intelligence Scale–Third Edition (WAIS-III; Wechsler, 1997); Elevator Counting, Telephone Search and Telephone Search whilst Counting from the Test of Everyday Attention (TEA; Robertson, Ward, Ridgeway, & Nimmo-Smith, 1994).
- Executive function: The Zoo Map task from the Behavioural Assessment of the Dysexecutive Syndrome battery (BADS; Wilson, Alderman, Burgess, Emslie, & Evans, 1996) and the Brixton Spatial Anticipation Test (Burgess & Shallice, 1997).

Generalisation of treatment

To measure generalisation across behaviours and knowledge of memory aid use, a Problem Solving Inventory (PSI) was developed for the current study based upon Troyer and colleagues (2001, 2008) assessments of memory strategy use. This was a list of 18 scenarios requiring the application of a memory strategy to everyday scenarios such as remembering past events, remembering to buy milk, or recalling instructions. Participants were asked to list as many strategies as possible for each situation under non-timed conditions. The PSI was administered at baseline and at follow-up. Responses were scored according to the total number of strategies listed and the number of different strategies listed.

Procedure

Treatment group participants were seen for five sessions: baseline assessment, three training sessions across a six week period and a follow-up assessment 18 weeks after baseline (12 weeks after the end of training). Participants in the control group were seen for baseline neuropsychological assessment and were then placed on a waiting list for 18 weeks after randomisation. This is equal to the length of treatment (6 weeks) and the follow-up period (12 weeks). Control participants then underwent treatment. At baseline, control participants were given written material on the management of memory problems ("Managing your Memory"; Kapur, 2001), with the explanation that treatment would be delayed. Control participants were waiting for the Memory Aids Service but received treatment as usual during this period. None of the control participants received psychological intervention from another agency during the waiting period and there were no changes in medication.

Baseline

The baseline session consisted of a clinical interview which included recording of demographic information, neuropsychological testing and the PSI. Goals were set collaboratively on the basis of current subjective complaints as described in the initial interview, informant feedback, and responses on a modified Everyday Memory Questionnaire (Sunderland, Harris, & Baddeley, 1983). Examples of goals included medication

management; remembering future plans, such as appointments; finding belongings; remembering recent or remote events; and remembering conversations and written material. Baseline goal attainment was then measured with the goal attainment diary. Significant others were enlisted to support diary completion or reminders were sent using an online automated text messaging service. In the treatment group, goal attainment was recorded at baseline, the end of training (six weeks after baseline) and at follow-up. Goal attainment for the control group was measured at the same time points – at baseline, six weeks after baseline whilst on the waiting list, and then three months later, immediately prior to treatment.

Treatment protocol

The intervention consisted of three sessions, 1.5–2 hours each, across a 6-week period. Memory aids were selected on the basis of the participant's goals, current memory aids and attitudes and preferences. Importantly, the participant was involved in the selection of the memory aid. The Memory Aids Service resource centre had a variety of aids that the treating clinical neuropsychologist (BKD) could offer to the participant. All memory aids were provided free of charge to participants to use at home.

A training protocol was developed for each memory aid to allow acquisition of knowledge about its components and how to apply its key functions to the participant's memory goals. Training began with a verbal description of the aid, and its components and use in relation to the participant's goals. Its use was then demonstrated. With reference to the training protocol, the participant then answered each training question or physically demonstrated use of the aid across three trials. Participants were encouraged not to guess if they did not know how to use the aid or if they did not know the correct answer to the training question. Training of the components and the application of the memory aid was complete after three correct trials. If severity of cognitive impairment made it difficult to use the training protocol, the aid could be programmed for the participant or spaced retrieval used to learn auditory or written presentation of a component instruction. One memory aid was introduced at a time. Mastery of the aids was reviewed with use of the training questions at subsequent sessions. Adaptation of the aid was facilitated by in-session exercises, discussion of hypothetical situations, and feedback about memory aid use in everyday life. Participants were given homework assignments at the end of every session to facilitate application of memory aid use in the home environment and to indirectly facilitate adaptation of use to different situations and settings. Participants were also given an information sheet for each aid.

Training of other memory strategies was conducted on a case-by-case basis. If a participant nominated remembering people's faces and names as a goal, errorless learning techniques were used in conjunction with external memory aids as described in Dewar, Patterson, Wilson, and Graham (2009). Learning of name/face association was supported by the use of a talking photo album, which allowed a recorded message to be played when viewing photographs. Remembering written material, such as a book or magazine article, was another challenging goal since few external memory aids were available to support this activity. Participants were offered the rehearsal strategy of PQRST (Preview, Question, Read and State, see Wilson, 2009, for a discussion) or trained in the use of a voice recorder to summarise key points from written material. Participants who were quick to learn how to use their selected memory aids were offered a modified version of Goal Management Training (GMT; Fish et al., 2007; Levine et al., 2000) as a means of more effectively using their system of memory aids.

Follow-up

Eighteen weeks after baseline, participants underwent a review interview, neuropsychological assessment and administration of the PSI. Goal attainment was again measured by the memory diary. The follow-up assessment was conducted by BKD who was not blind to the intervention received.

Outcome

Data from the Wilson et al. study (2003) into the use of Neuropage were used for the power analysis to establish participant numbers. On the basis of two-sided testing and with power set at 90%, the aim was to recruit 60 participants to the treatment group and 20 participants to the control group to achieve a significant result with sufficient power.

The main outcome measure was achievement of everyday memory goals as measured by the memory diary. The effect of treatment on this measure was compared between the treatment and control groups across the three time points of baseline, end of training (6 weeks after baseline) and follow-up (18 weeks after baseline). Generalisation of treatment was measured by responses on the PSI at baseline and follow-up. The effectiveness of treatment for participants with a non-progressive neurological condition or a progressive neurological condition was compared across baseline, end of training and follow-up. Generalisation of treatment was again measured by the PSI responses across non-progressive and progressive groups across baseline and follow-up.

The main dependent variable in this study was the change in functional goal attainment as measured by the memory performance diary across the time points of baseline, end of training and follow-up. A two way mixed ANOVA was conducted with the variables of time and group. Independent *t*-tests were then conducted across groups at baseline, at the end of training (six weeks after baseline) and at follow-up. Change on the PSI was examined with a mixed ANOVA with the variables of time and group and independent *t*-tests. Analyses were conducted to compare effectiveness of treatment for participants with a progressive or non-progressive disease. Comparisons were made within groups (non-progressive group or progressive group) between treatment and control participants with overall ANOVAs. If there was a significant effect, then *t*-tests were then performed. A final comparison was made between participants in the treatment group with a non-progressive or a progressive condition with an overall ANOVA and independent *t*-tests. Change on the PSI was examined within groups across baseline to follow-up with independent *t*-tests. Performance on neuropsychological tests at baseline and follow-up were also analysed with *t*-tests.

Results

A total of 128 participants were recruited. As shown in Figure 1, 88 participants were included in the treatment group, of whom 63 completed training. The treatment group included 44 participants with a static, non-progressive condition, in which there had been a one-off cerebral insult with no evidence of subsequent progression, and 19 with a condition that is invariably progressive, such as AD or vascular cognitive decline. The diagnoses of the treatment participants in the non-progressive subgroup

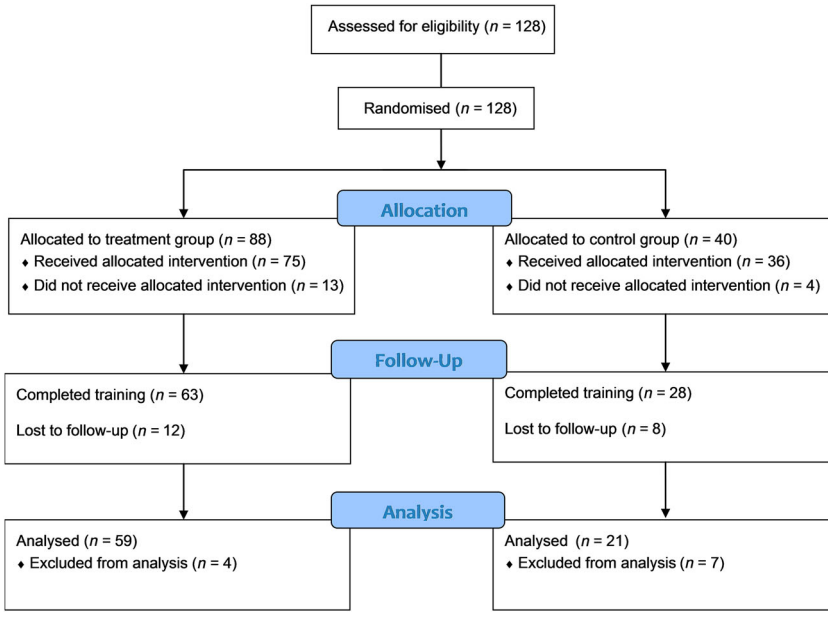

Figure 1. Allocation of study participants to treatment and control groups.

were stroke or "vascular" ($n = 8$); seizure disorder ($n = 8$); traumatic brain injury ($n = 6$), ranging from severe to post-concussion syndrome; hypoxic brain injury ($n = 5$), including two with presumed perinatal injuries; human immunodeficiency virus ($n = 4$); brain tumour ($n = 4$); encephalitis ($n = 3$); systemic lupus erythematosus ($n = 3$); alcohol-related cerebral dysfunction ($n = 2$); and myalgic encephalopathy ($n = 1$). Diagnoses of treatment participants in the progressive sub-group were: mild cognitive impairment ($n = 12$); Alzheimer's dementia ($n = 3$); "vascular", such as small vessel disease ($n = 2$); and multiple sclerosis ($n = 2$).

Of the 40 participants in the control group, 24 completed training, including baseline and follow-up assessment. The control group included 10 participants with progressive and 14 participants with non-progressive conditions. Of the control participants who had a non-progressive condition, the diagnoses were: alcohol-related brain dysfunction ($n = 5$); "vascular", including stroke ($n = 4$); seizure disorders ($n = 3$); traumatic brain injury ($n = 1$); and hypoxic brain injury ($n = 1$). The control participants in the progressive sub-group had diagnoses of: Alzheimer's dementia ($n = 5$); "vascular" ($n = 3$); and mild cognitive impairment ($n = 2$).

As noted in Figure 1, 12 treatment group participants and 8 control group participants did not complete training following the baseline assessment due to failure to attend appointments, refusal of the offer of treatment, or moving out of area. The baseline performance of these subjects was compared to respective treatment and control participants who completed treatment to explore any reasons for treatment drop out. Treatment group participants who discontinued had a lower level of education ($t = 6.29$, $p < .01$). Control group participants who did not complete training used fewer memory aids at baseline compared to those who continued ($t = 2.20$, $p = .04$).

Performance of all participants on the memory diary was inspected visually prior to data analysis. A number of outliers were identified and excluded from the analysis. Four treatment group participants were excluded on the basis that they did not record any everyday memory problems in the memory diary. Three control group participants were excluded as performance on the memory diary was at floor. They had severe and generalised impairment on neuropsychological assessment and demonstrated poor insight into their memory difficulties. Four of the control subjects underwent treatment with a pilot protocol and were excluded from the analysis. Missing data for the memory diary were excluded on a case-by-case basis.

The demographics of the treatment and control participants are presented in Table 1. There was no significant difference in the ratio of males to females ($\chi^2 = 1.06$, $p = .30$) or progressive to non-progressive condition ($\chi^2 = 0.62$, $p = .43$) across the treatment and control groups. There were near significant differences between the treatment ($n = 59$) and control group ($n = 21$) in terms of scores performance on the RBMT E ($t = 1.84$, $p = .07$). There were no significant differences in terms of age ($t = -1.74$, $p = .90$) or number of years of education ($t = 1.46$, $p = .15$).

Comparison of treatment and control groups

Comparison of the memory performance diary between the treatment and control group across baseline, end of training and follow-up is shown in Figure 2. There was a significant effect of time as both groups improved their memory diary performance from baseline to the end of training, $F(1, 49) = 15.26$, $p < .01$. From baseline to the follow-up period, there was a significant effect of time, $F(1, 55) = 8.93$, $p < .01$, and a significant group by time interaction, $F(1, 55) = 3.93$, $p = .05$. Inspection of average goal attainment across groups at these time points indicates that improved memory performance was only maintained in the treatment group. From the end of training to the follow-up period, there was no significant effect of time, $F(1, 43) = 2.56$, $p = .12$, or group, $F(1, 43) = 0.78$, $p = .38$, or group by time interaction, $F(1, 43) = 0.01$, $p = .98$. Comparison of goal attainment between groups (treatment and control) at different time points in the training programme (baseline, end of training and follow-up) with an independent *t*-test analysis (two tailed) confirmed that at follow-up, there was a significant difference in goal attainment between groups, $t(56) = 2.99$, $p < .01$. Goal attainment was higher in the treatment group (mean = 67.1, $SD = 23.7$) relative to the control group (mean = 50.4, $SD = 16.1$).

Table 1. Sample characteristics of participants at baseline.

	Treatment Group ($n = 59$)		Control Group ($n = 21$)	
Gender (M:F)	33:26		9:12	
Disease course (non-progressive: progressive)	42:17		13:8	
	Mean (*SD*)	Range	Mean (*SD*)	Range
Age, years	52.5 (13.5)	21–81	58.7 (15.4)	35–81
Education, years	12.6 (3.3)	8–23	11.4 (2.9)	9–18
Time since insult, months	62.9 (76)	1–360	40.9 (64.3)	1–252
Number of memory aids	6.3 (2.3)	2–13	7.0 (1.6)	4–10
Estimated Premorbid IQ	103.3 (14.9)	67–127	100.9 (15.1)	70–124
RBMT-E Profile Score	18.6 (9.4)	2–50	14.4 (6.9)	1–25

RBMT-E = Rivermead Behavioural Memory Test–Extended version, *SD* = standard deviation.

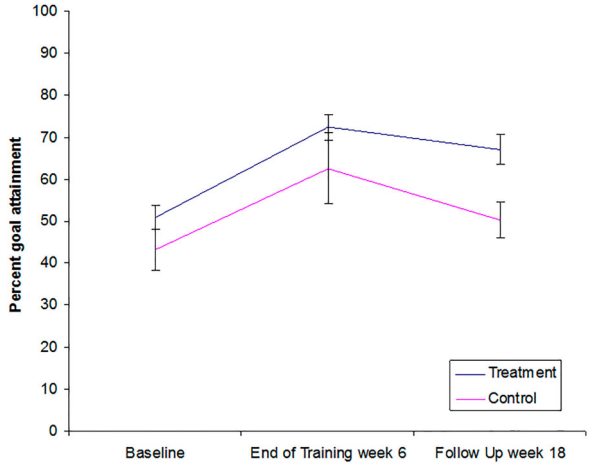

Figure 2. Memory performance diary ratings of treatment and control subjects across baseline, end of training and follow-up.

There were no significant differences between treatment and control participants at baseline, $t(66) = 1.31$, $p = 1.93$, or at the end of training, $t(51) = 1.38$, $p = .17$.

Outcome of non-progressive group

Comparison of treatment and control participants with a non-progressive condition is shown in Figure 3. There was a significant main effect of time as performance on the memory performance diary changed for both groups, $F(2, 58) = 7.19$, $p < .01$. There was no significant main effect of group, $F(1, 29) = 2.56$, $p = .12$. There was a significant group by time interaction, with the treatment group significantly increasing everyday memory performance relative to the control group, $F(2, 58) = 3.40$, $p = .04$, across time.

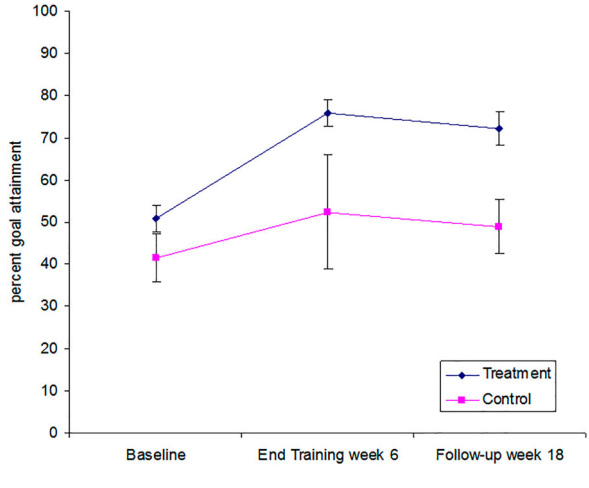

Figure 3. Everyday memory performance of participants with a non-progressive condition across baseline, end of training and follow-up.

To facilitate comparison with performance of the progressive participants, *t*-tests were conducted to compare mean goal attainment at baseline, the end of training, and at follow-up. At baseline, there was no significant difference between groups, $t(48) = 1.43$, $p = .16$. At the end of training, there was a significant difference between treatment and control participants, with treatment group participants achieving greater scores of everyday memory performance, $t(34) = 2.59$, $p = .02$. At follow-up, there was a significant difference in functional goal attainment between groups, $t(39) = 2.77$, $p = .01$.

Outcome of progressive group

Comparison of memory performance between treatment and control participants with a progressive condition is shown in Figure 4. There was a significant main effect of time as performance on the memory performance diary changed for both groups, $F(2, 22) = 3.982$, $p = .03$. However, there was no significant main effect of group, $F(1, 11) = 2.24$, $p = .16$, and no significant group by time interaction, $F(2, 22) = 0.60$, $p = .56$. Analysis using *t*–tests confirmed the absence of a significant difference between treatment and control subjects at baseline, $t(17) = -0.42$, $p = .68$, the end of training, $t(16) = -1.51$, $p = .15$, and follow-up, $t(16) = -0.56$, $p = .59$.

Treatment group comparison

A final comparison was made between subjects in the treatment group with a non-progressive condition and those with a progressive condition on everyday memory diary performance. There was a significant effect of time as performance on the memory diary changed for both groups, $F(2, 41) = 12.78$, $p < .01$. There was no significant group by time interaction, $F(2, 41) = 2.16$, $p = .13$. Independent *t*-tests were conducted to examine differences between these groups at baseline, the end of training and follow-up. At baseline, there was no significant difference in memory diary performance between participants, $t(51) = -0.35$, $p = .97$. At the end of training, there was a significant

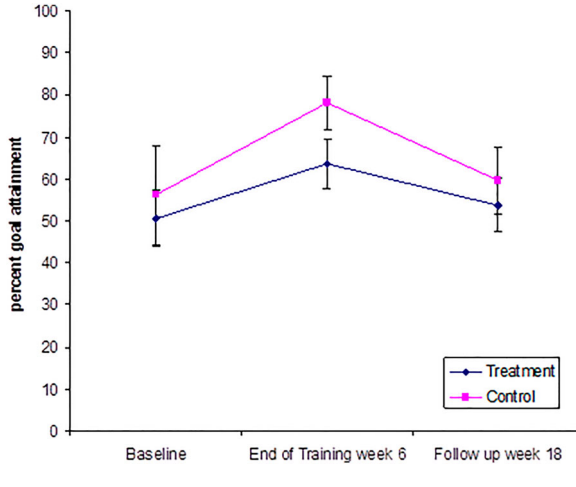

Figure 4. Everyday memory performance of participants with a progressive condition across baseline, end of training and follow-up.

difference between groups, $t(40) = -2.00$, $p = .05$, with non-progressive participants achieving a higher percentage of goal attainment. At follow-up, the difference remained such that participants with a non-progressive condition attained significantly higher goal attainment relative to participants with a progressive condition, $t(42) = -2.39$, $p = .02$.

Problem Solving Inventory

Performance on the PSI of participants with a non-progressive condition was explored with a comparison between treatment and control participants with the use of independent *t*-tests at baseline and follow-up. There were no significant differences in number of memory aids suggested at baseline, $t(42) = -0.80$, $p = .43$, or at follow-up, $t(36) = 0.85$, $p = .40$; in the number of memory strategies suggested at baseline, $t(42) = -0.82$, $p = .42$, or at follow-up, $t(36) = 0.57$, $p = .57$; or the number of different memory aids or strategies at baseline, $t(43) = -1.03$, $p = .31$, or follow-up, $t(36) = -0.24$, $p = .98$. Performance at baseline and follow-up for treatment and control participants is shown in supplementary Table S1.

Responses on the PSI for progressive participants were explored with independent *t*-tests to compare performance between treatment and control participants at baseline and follow-up. Whilst there was no significant difference at baseline, $t(16) = 1.547$, $p = 0.14$, at follow-up, participants with a progressive condition in the treatment group suggested a significantly higher number of memory aids in hypothetical memory scenarios than those in the control group, $t(14) = 2.11$, $p = .05$. There was no significant difference between the number of memory strategies at baseline, $t(16) = -1.298$, $p = .21$, or at follow-up, $t(14) = 0.62$, $p = .55$; or any significant difference between the diversity of memory aids or strategies suggested at baseline, $t(16) = 0.94$, $p = .36$, or at follow-up, $t(14) = 0.19$, $p = .86$.

Neuropsychological test performance

Performance of treatment subjects with a non-progressive or progressive condition on the neuropsychological battery across baseline and follow-up is shown in

Table 2. Comparison of treatment participants with non-progressive or progressive condition on neuropsychological battery.

Measure	Non-progressive treatment participants ($n = 42$)	Progressive treatment participants ($n = 17$)	*p*-value
	Mean (*SD*)	Mean (*SD*)	
Estimated FSIQ	101.0 (14.0)	105.7 (16.4)	.22
RBMT E PS	19.7 (8.5)	15.6 (11.2)	.13
Camprompt	21.3 (8.8)	13.2 (8.6)	**<.01**
WAIS-III DSym SS	7.1 (2.7)	6.6 (3.5)	.60
WAIS-III LettNo SS	7.2 (3.3)	6.6 (3.4)	.54
El Count	6.1 (1.6)	6.2 (1.3)	.67
Tel Search SS	7.7 (3.1)	6.9 (2.9)	.41
Tel Search Count SS	8.2 (4.8)	7.0 (4.2)	.36
Zoo Map PS	1.8 (0.9)	1.3 (1.1)	.06
Brixton PS	4.8 (2.4)	3.6 (2.2)	.09

FSIQ = Full scale IQ; RBMT E = Rivermead Behavioural Memory Test–Extended version; WAIS-III = Wechsler Adult Intelligence Scale Third edition; Digit Sym = Digit Symbol subtest from WAIS-III; Lett/No = Letter Number Sequencing subtest from WAIS-III; TEA = Test of Everyday Attention; El Count = Elevator Count subtest; Tel Search = Telephone Search; Tel Search + Count = Telephone Search While Counting; BADS = Behavioural Assessment of the Dysexecutive Syndrome; SS = scaled score; PS = profile score.

supplementary Table S2. Given the significant difference between non-progressive and progressive treatment group participants on goal attainment as measured by the memory diary, independent *t*-tests were conducted to examine any differences in neuropsychological test performance at baseline and across time as shown in Table 2. Treatment participants with a progressive condition performed worse on a test of prospective memory, $t(57) = -3.43$, $p < .01$. There was a near significant effect for participants with a progressive condition to perform worse than non-progressive participants on executive tests of planning: Zoo Map, $t(57) = -1.93$, $p = .06$; and non-verbal concept formation: The Brixton Spatial Anticipation Test, $t(57)$ −1.736, $p = .09$.

Discussion

The current study investigated the effectiveness of systematic training in the use of compensatory memory aids on everyday memory function of people with acquired memory disorders. Use of compensatory memory aids within a memory aids clinical service setting was effective in improving attainment of everyday memory goals but only for those participants with a non-progressive neurological condition. Participants with a non-progressive condition increased functional goal attainment following training in the Memory Aids Service and this improvement was maintained across time. In contrast, there was no advantage of treatment for participants with a progressive condition, with no difference in goal attainment between treatment and control participants across time. The finding of a significant treatment effect for participants with a non-progressive condition is consistent with the literature on the effectiveness of memory aids and supports the use of a systematic approach to training memory aids in an outpatient service to achieve everyday memory goals.

Training in the use of memory aids

The systematic approach to training in the use of memory aids was developed on the basis of Sohlberg and Mateer's (1989) model of skill acquisition, application and adaptation which was initially developed to train memory notebooks following traumatic brain injury. This training model has been extended to include a pre-treatment planning stage (Sohlberg & Turskra, 2011). Although the current study was implemented prior to this revision, treatment planning and analysis of each memory aid echoes the Plan, Implement and Evaluate model suggested by these authors. The key elements of the Memory Aids Service can be summarised as collaborative goal setting, task analysis of how to use and apply each memory aid, modelling of behaviour, use of error reduction techniques, opportunities for extended practice including compliance measures between sessions, and probes to determine retention of previously learnt information.

Goal setting allows the outcome of a rehabilitation programme to be measured effectively. The memory performance diary was developed for the current study on the basis of the outcome measure used in the Neuropage evaluations (Wilson et al., 2003). Measurement of outcome in rehabilitation is difficult due to the heterogeneity of patients and of desired treatment outcomes (Turner-Stokes, 2009; Wilson, 2009). This was reflected in the heterogeneity of the clinical sample in the Memory Aids Service participants with the identification of 24 different goals. The memory performance diary aimed to capture these individual goals as opposed to a one-size-fits-all

measure whilst providing a quantitative measure of performance with good ecological validity. The definition of success each day was defined following Kime's (2006) recommendation that if a response is not 100% accurate, then the compliance measure should be marked "No" so as to facilitate learning of the correct behaviour. Thus, the positive results of the current study are robust and reflect successful goal attainment, as partial success was scored as a "no" response in the diary.

The training elements that facilitated the transfer of learning from the clinic to the home/social environment included the identification and discussion of everyday memory goals, the focus upon teaching skills to compensate for everyday memory problems, provision of compliance sheets to ensure use of the memory aids between training sessions, and varied opportunities to practise within sessions. The use of "real world" and personal examples within the Memory Aids Service training may also have underpinned the transfer of training (Sohlberg & Raskin, 1996). Training on multiple and personal examples would also have supported flexible learning (Stark, Stark, & Gordon, 2005) under the error reduction conditions utilised in the training programme. The Memory Aids Service was an outpatient service and was comprised of only three training sessions. To support further the transfer of training from the clinic to the participant's home and social environment, additional training sessions are recommended in future to include a home and/or community visit. This would enable a careful match of memory aid use to the environment in which new skills are to be applied and adapted (Kime, 2006; Prigatano & Kime, 2003).

A holistic approach to training in the use of memory aids

Rehabilitation within the Memory Aids Service aimed to be holistic with collaborative goal setting and careful planning of the intervention on the basis of information collected at the baseline session. The selection of memory aids and planning of treatment addressed the need for matching the memory aid to the client's needs (Gilette & DePompei, 2004) and his or her individual characteristics (Scherer, Sax, Vanbiervliet, Cushman, & Scherer, 2005). Memory aids were selected on the basis of the participant's goal and individual preferences; physical and sensory limitations were also considered. The setting of the memory aids library facilitated the personal selection of a device and overcame the barrier of financial access to memory aids. Provision of memory aids may also have supported long-term use by allowing immediate use of the device following training; and active involvement in selection of the memory aid may have promoted greater user involvement in the training process (Wessels et al., 2003).

All participants were provided with feedback about their assessment results, and the process of recovery and rehabilitation following acquired brain injury was discussed with the aim of increasing awareness. A more robust treatment effect might have been facilitated by incorporation of additional "pre-treatment" sessions to enhance motivation and engagement prior to skills acquisition training. Motivational interviewing is a therapeutic approach that aims to enhance intrinsic motivation to change by exploring and resolving ambivalence, and it has been increasingly applied to brain injury rehabilitation (Hsieh et al., 2012; Medley & Powell, 2010). A pre-treatment session in the Memory Aids Service may have adopted a motivational interviewing approach to enhance the participants' readiness for treatment by mediating self-awareness and increasing commitment to therapy goals. The addition of an extra session prior to training to focus on awareness has been used successfully in the training of memory

notebooks with both people with acquired brain injury (Fleming, Shum, Strong, & Lightbody, 2005; Schmitter-Edgecombe, Fahy, Whelan, & Long, 1995) and mild dementia (Schmitter-Edgecombe et al., 2008).

Memory aids and progressive neuropsychological disorders

The lack of benefit of memory aids for participants with a progressive condition is in contrast with some of the recent literature (see Clare et al., 2009, 2010; Greenaway et al., 2012). In the current study, differences in neuropsychological baseline performance were evident between treatment participants with a non-progressive condition and those with a progressive condition. Prospective memory performance was poorer for progressive participants, with non-significant trends for poorer executive function. The current findings suggest that it is more difficult to train people with progressive conditions to effectively use memory aids and that participants with a progressive memory disorder may require more intensive rehabilitation across more sessions to support vulnerable memory and executive functioning. The Memory Aids Service offered three training sessions, with provision of homework in between sessions, to address an average of three memory goals. Indeed, the three hours of training offered in the Memory Aids Service due to funding restrictions is lower than the average number of treatment hours reported for memory aid rehabilitation studies with non-progressive participants (Prigatano & Kime, 2003; Van Heugten, Gregório, & Wade, 2012). Additional sessions may have allowed for greater mastery of memory aids and successful goal attainment prior to addressing the next goal (Clare et al., 2010; Ehlhardt-Powell et al., 2012) and involvement of significant others as co-therapists (Clare et al., 2010; Schmitter-Edgecombe et al., 2008). The absence of an effect for participants with a progressive condition may also reflect small subject numbers recruited from the Memory Disorders Clinic and thus insufficient power.

Participants with a progressive condition with more vulnerable cognitive function may also have benefited from training within the context of general memory rehabilitation. A number of successful group interventions for people with AD or MCI have been described that combine training in the use of memory aids within the context of more general strategies for cognitive difficulties and management of everyday problems (Clare et al., 2010; Kinsella et al., 2009; Troyer, 2001). In the current study, participants in the progressive group endorsed the use of more memory aids on the PSI than respective control participants. This suggests that the effect of treatment in the Memory Aids Service for people with a progressive condition is to increase awareness of memory aids and how they can be applied in everyday life, akin to the findings of Troyer (2001).

The current study had a number of limitations. Compliance with completion of the memory diary could have been increased by enlisting the support of a significant other or carer to complete the daily record, such as described in the evaluation of Neuropage (Wilson, Emslie, Quirk, Evans, & Watson, 2005) and Google calendar (Mcdonald et al., 2011), also improving the reliability of responses (see Roche, Fleming, & Shum, 2002). Alternative measures and established measures of outcome, such as the Canadian Occupational Performance Measure (see Hurn, Kneebone, & Cropley, 2006) could have increased the reliability of the results. The absence of benefit for participants with a progressive condition may reflect the small sample size within this group and future studies could focus on the recruitment of only people with MCI or AD to determine the efficacy of systematic training with memory aids in this population. Future

studies should also explore the optimum number of sessions required for training memory aids in progressive neurological disorders. In the current study there were near significant trends for differences between the treatment and control group on standardised measures of everyday memory. This significant difference suggests that everyday memory measures may have been used as a covariate to exclude the lower performance of the control group as due to poorer memory.

There were a number of methodological limitations in the current study. These included the lack of randomisation and lack of allocation concealment to the treating neuropsychologist. Ideally, use of two neuropsychologists to conduct training and assessments would have allowed a blind measurement of outcome and avoided any bias in interpretation of results. However, resources were not available. Participants were classified into progressive and non-progressive groups, according to diagnosis, but were not recruited in a stratified fashion. Whilst alternative neuropsychological tests were adopted across the baseline and follow-up assessments, these forms may not have been equivalent, and added additional error variance to the results.

There is a wealth of literature on the effectiveness of memory aids in supporting the everyday function in acquired brain injury and neurological conditions (Sohlberg, 2006). There is a need to describe how to train individuals with cognitive and memory impairments to effectively use memory aids. Given the rapid proliferation of assistive technology devices in addition to the wide range of low technology supports, it is not practical to investigate the effectiveness of each memory aid. Gillespie, Best, and O'Neill (2012) have conceptualised high technology memory aids in terms of cognitive functions, e.g., alerting, reminding, and storage, which helps to generalise results from specific memory aids studies toward cognitive functions as defined by the International Classification of Functioning (ICF; WHO, 2001). This conceptualisation can be used to select appropriate and effective memory aids to meet everyday memory goals developed in terms of participants' everyday function and participation in keeping with the ICF. The training programme developed and evaluated within the Memory Aids Service described in this paper provides a platform to allow people with acquired memory impairments to use these memory aids effectively to meet everyday functional goals.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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