Journal of the International Neuropsychological Society (2003), **9**, 925–935.

DOI: 10.1017/S1355617703960127

Who makes good use of memory aids? Results of a survey of people with acquired brain injury

JONATHAN J. EVANS,[1,2] BARBARA A. WILSON,[1,2] PAUL NEEDHAM,[1] AND SUE BRENTNALL[1]

[1]The Oliver Zangwill Centre, Princess of Wales Hospital, Ely, UK
[2]MRC Cognition and Brain Sciences Unit, Cambridge, UK

(RECEIVED January 2, 2001; REVISED November 15, 2002; ACCEPTED December 16, 2002)

Abstract

Wilson and Watson (1996) identified several factors that were associated with use of memory aids and strategies in a group of people with acquired brain injury. The present study tested these findings, with the aim of identifying the variables that best predict effective use of memory aids after brain injury. One-hundred and one people with memory problems arising from brain injury and their carers were interviewed to identify the aids/strategies used to compensate for memory impairment, and the efficacy of their use. Information relating to variables previously found, or hypothesized to predict use of memory aids, was collected. Use of memory aids correlated with level of independence. External aids such as calendars, wall charts, and notebooks were the most commonly used memory aids. Electronic organizers were not used by many participants. The variables that best predicted use of memory aids were (1) current age, (2) time since injury, (3) number of aids used premorbidly, and (4) a measure of attentional functioning. The implications for rehabilitation services are discussed. (*JINS*, 2003, *9*, 925–935.)

Keywords: Brain injury, Memory impairment, Memory aids, Rehabilitation

INTRODUCTION

An impairment of memory is amongst the most common sequelae of brain injury arising from such causes as traumatic head injury, stroke, or encephalitis. While there may be some recovery of memory functions in the acute phase following the injury, many individuals are left with permanent impairments. Among rehabilitation professionals, there is a broad consensus that the most effective way of helping such individuals to cope with everyday life is through the use of compensatory strategies (Berg et al., 1991; Glisky, 1995; Kapur, 1995; Wilson, 1991). In a recent review of cognitive rehabilitation, Robertson (1999) wrote, "In the case of memory rehabilitation, there is as yet no evidence for direct and lasting improvement of memory through restitution-oriented therapies. Hence, compensatory approaches to memory problems appear to be, for the time being at least, the treatment of choice" (p. 704). Compensatory strategies include external remembering aids (such as diaries, notebooks, and electronic organizers), internal strategies (such as visual-association techniques for remembering names), and environmental adaptations (such as labelling cupboards).

Despite this emphasis on the use of memory aids, it is clear that while some people use such aids apparently effectively, others seem to make little or no use of such aids. Wilson (1991) followed up a sample of 43 memory-impaired individuals who had previously undergone rehabilitation. She found that there was a relationship between the number of memory strategies being used and whether or not the person functioned independently. The most commonly used strategies were notes/notebooks, mental retracing of events, calendars, and lists. Wilson and Watson (1996) examined these data further in an attempt to identify the characteristics of people who made good use of memory strategies and those who did not. All participants in the Wilson and Watson study had undergone a period of rehabilitation and were several years postinjury. Although some made heavy use of such aids, others did not. Wilson and Watson found that the following factors predicted use of six or more memory aids

Reprint requests to: Dr. Jonathan J. Evans, Associate Director of Research and Consultant Clinical Psychologist, The Oliver Zangwill Centre, Princess of Wales Hospital, Lynn Road, Ely, Cambs. CB6 1DN, UK. E-mail: jonathan.evans@pow.lifespan-tr.anglox.nhs.uk

(which had been demonstrated to predict level of independence): (1) age (being under 30 years at the time of the insult); (2) severity of memory problem (people with a higher score on the Rivermead Behavioural Memory Test, albeit in the impaired range, were using more aids); (3) the absence of additional cognitive deficits (individuals with a more pure amnesic syndrome made greater use of memory aids); (4) absence of marked executive deficits (those without marked executive deficit were using more aids); and (5) whether or not individuals were using memory aids premorbidly (people who used five or more aids premorbidly made greater use of memory aids postinjury).

The main aim of the present study was to test the findings of Wilson and Watson in a larger sample of people with acquired brain injury. We also identified a number of additional factors of interest not previously examined by Wilson and Watson that we believed might have some bearing on the use of memory aids. For example, although Wilson and Watson identified that the presence of cognitive impairments in addition to memory impairment predicted less use of memory aids, they did not include a measure of current general intellectual functioning. We therefore examined whether performance on Ravens Standard Progressive Matrices (RSPM; Raven, 1976), a test of nonverbal problem solving, predicted level of memory-aid usage. Attentional skills have been demonstrated to be important predictors of functional recovery after stroke (Robertson et al., 1997). We therefore speculated that those participants with better attentional skills would be more likely to make more use of memory aids. Mood disorders are common sequelae of brain injury and we were therefore interested to identify whether this factor had a predictive effect on memory-aid usage. Finally, we wondered whether time since injury would be a relevant variable. Adaptation to the consequences of brain injury is a process that can take some considerable time. We speculated therefore that time since injury would be likely to predict level of memory-aid usage as participants gradually develop greater insight into the nature of their memory impairment and recognize that the use of compensatory aids will have a positive effect on their functioning. In addition to examining the individual relationship between specific variables and level of memory-aid use, we wanted to examine which *combination* of factors best predicted use of memory strategies among our sample of individuals with memory impairment.

METHOD

Research Participants

One-hundred and one people with memory problems were recruited to the study. None of these were previously participants in the Wilson and Watson (1996) study. The main criteria for inclusion in the project were (1) self-report of everyday memory problems, and (2) history of acquired brain injury. Participants were recruited through a local day center for people with brain injury, and through a number of different brain injury services or research units. Day-center staff or treating clinicians were asked to identify potential participants on the basis that there was evidence that memory problems were significantly disrupting everyday activities. The approach to recruitment was designed to obtain a broad sample with regard to variables such as age, time since injury, and aetiology, in order that the sample was likely to be reasonably representative of people with acquired brain injury.

Of the 101 people who were initially recruited, data from three people were excluded as it was not possible to complete the assessments. Of the remaining 98, it was not possible to obtain information from a relative for four participants and thus the main analyses were carried out using data from 94 participants. General demographic characteristics of the participants are shown in Table 1. There were 64 males and 30 females in the sample. The premorbid socioeconomic status of the sample was as follows: unskilled (5), partly skilled (13), skilled manual (26), skilled nonmanual (14), intermediate (20), professional (4), pupil/student (11), and unemployed (1). There was a wide variety of causes of brain injury, including road traffic accident—car driver (43.6%), fall (13.8%), cerebro-vascular accident (9.6%), epilepsy related (8.5%), road traffic accident—pedestrian (7.4%), road traffic accident—cyclist (5.3%), viral encephalitis (3.2%), assault (2.1%), explosion (1.1%), Korsakoff's syndrome (1.1%), meningitis (1.1%), tumor (1.1%), hydrocephalus (1.1%), and carbon monoxide poisoning (1.1%).

In Wilson's (1991) study, 56.1% of the participants were classified as being independent (in paid employment or full-time education or living alone), with 43.9% not reaching criteria for independence. In the present study, the definition of independence was modified slightly to include, in

Table 1. Summary statistics of the brain injured sample ($n = 94$)

	Age now	Education (years)	Years since insult	Age at insult	Length of coma (days)
Mean	39.53	11.95	5.89	33.47	15.24
Standard deviation	13.38	2.13	4.79	13.20	34.02
Minimum	17	9	1	11	0
Maximum	70	19	26	62	280

https://doi.org/10.1017/S1355617703960127 Published online by Cambridge University Press

addition to those in paid employment, study or living alone, individuals who were living with family, but who were taking a significant role in running a household/caring for children (e.g., taking responsibility for family finances, caring for children alone). In the present sample, 44 participants (46.8%) met the criteria for independence, with 50 participants (53.2%) not reaching the criterion. Thus, although the present sample had slightly lower percentage of people who were independent, the sample was broadly similar to that in Wilson's (1991) study.

Of the 94 subjects, 81 reported a history consistent with a period of coma and posttraumatic amnesia (PTA). The remaining 13 reported either no coma or uncertainty with regard to the length of coma. The median length of coma was 7 days. For those reporting a period of PTA, the modal length was longer than 4 weeks ('extremely severe').

Materials

A range of demographic and neuropsychological test information was obtained in order to characterize the sample of participants taking part in this study:

Background information

Information relating to general demographics and injury-related information was obtained using a questionnaire administered by the researcher. Information obtained from the participant was confirmed with a relative/carer.

Current cognitive functioning

A range of standardized neuropsychological assessments was used to obtain information relating to a number of cognitive function domains. The tests used were as follows:

1. Rivermead Behavioural Memory Test (RBMT; Wilson et al., 1985).
2. Speed of Processing Test from the Speed and Capacity of Language Processing Test Battery (SCOLP; Baddeley et al., 1992).
3. Ravens Standard Progressive Matrices (RSPM; Raven, 1976).
4. Graded Naming Test (GNT; McKenna & Warrington, 1983).
5. National Adult Reading Test–Revised (NART–R; Nelson & Willison, 1991),
6. Map Search task from the Test of Everyday Attention (TEA; Robertson et al., 1994).
7. Visual Object and Space Perception battery—Shape detection, incomplete letters, and cube analysis (VOSP; Warrington & James, 1991).

A set of questionnaires was also administered to clients (and relatives in the case of the Dysexecutive Questionnaire and European Brain Injury Questionnaire) as follows:

1. Dysexecutive (DEX) Questionnaire from the Behavioural Assessment of Dysexecutive Syndrome (Wilson et al., 1996). This questionnaire was included to sample the views of client (DEX-Self) and relatives/carers (DEX-Other) on the presence or absence of features of a dysexecutive syndrome.

2. The European Brain Injury Questionnaire (EBIQ; Teasdale et al., 1997). This questionnaire samples client and relative's perspectives of a range of psychosocial consequences of brain injury.

3. General Health Questionnaire 12 (GHQ; Goldberg, 1972). This questionnaire is a mood and general health perception questionnaire that assesses subjective experience of mood disorder and general health.

Compensatory aids/strategies checklist

A checklist of the most common memory strategies was compiled. Using the checklist, a researcher asked participants to identify all of the strategies they were using to compensate for memory difficulties. Any strategies identified by participants that were not already on the list were immediately added to it. Participants were also asked to rate the frequency of use of the aids and the perceived effectiveness of the aids. For the effectiveness rating, participants were asked to make a judgement as to whether each aid they used was effective (i.e., provided the information or reminder intended) "rarely", "sometimes" or "usually". One version was completed with the participant and one with the relative/independent other person. Nonparametric correlational analysis indicated that the ratings provided by participants and relatives in relation to memory aids used were significantly correlated for both frequency of use (rho = .482, $p < .01$) and efficacy (rho = .427, $p < .01$). However, given that there was a degree of discrepancy between the relatives and the participants, it was decided that, for the purpose of statistical analysis, the ratings provided by relatives would be used, on the assumption that the information would be more reliable. In the case of 11 participants, it was adjudged that the relative/carer would not be able to make an accurate judgement of memory-aid usage. This was usually because the participant lived independently of the relative/carer. Nine of these 11 participants were rated as independent and were judged on clinical grounds to be sufficiently reliable historians for self-rating data relating to their use of memory aids premorbidly and postmorbidly to be included. Two participants did not meet the criteria for independence, but they were known to rehabilitation services and treating clinicians confirmed that self-report measures of memory-aid use were accurate. Participants (patients/relatives) were also asked which aids they used premorbidly. In this case, relatives relied on both their own knowledge and information from discussion with the patient in order to identify premorbid memory-aid usage. This rating was therefore a consensus view.

https://doi.org/10.1017/S1355617703960127 Published online by Cambridge University Press

Procedure

Participants and their relative/carer were usually seen over the course of two visits. When possible the background questionnaire was administered first, followed by the EBIQ, RBMT, GHQ-12, Speed of Processing Test, DEX, GNT, and Map Search. On the second visit, the Compensatory Strategies Questionnaire was given before the Ravens Matrices and finally the NART. The aim of using this structure was to avoid excessive fatigue effects. On occasion, limits on the time available or the fatigue of the participant altered the order of tests, as did the availability of the independent rater.

RESULTS

Cognitive Characteristics of the Participants

Table 2 presents summary information relating the performance by the participants on the cognitive tests administered. The percentage of the sample showing impairment on the tests is shown. Impaired performance was defined by test manual recommendations or by using a 5th percentile cutoff. It should be noted that for some variables, participants may have demonstrated some impairment in performance from premorbid levels without necessarily reaching the 5th percentile level. This means that the figures presented may represent an underestimate of the percentage of the sample showing *some* degree of impairment in the domains sampled. Nevertheless, these data show that the sample of participants demonstrated a typical pattern of impairments associated with brain injury, particularly head injury. There was a wide range of performance on each test, but as a group the participants demonstrated impairments in memory, attention, and speed of information processing, in the context of better preserved basic language and perceptual skills. Although some participants showed severe impairments on some tests, none were so impaired that they were unable to understand or carry out the basic task requirements.

Memory Strategies Used by Participants

A total of 44 different strategies were being used by participants in the sample. Table 3 provides a list of these together with information on how many people were using each aid. The most commonly used strategy is a calendar or wall chart. Sixty-eight of the sample reported using this method. A notebook was used by 60 participants and lists were used by 59 of the participants. It is noteworthy that the four most commonly used memory aids/strategies were all external aids. The most commonly used internal strategy is mental retracing (to find missing objects). Only seven participants (7.4%) of the sample reported using electronic organizers as memory aids. Table 3 also contains data on the mean scores for the efficacy ratings made by carers with regard to each aid/strategy. These data should be treated with caution for those aids where only a small number of participants were using a particular aid. However, the data do

Table 2. Performance of the participants on a range of standardized tests of cognitive function

Test	Mean (*SD*)	Min.	Max.	Normative sample mean (*SD*)	Percentage of sample falling below test impairment cutoffs
National Adult Reading Test (number of errors)	22.9 (10.6)	4	47	18.8 (11.7)	0
Ravens Standard Progressive Matrices (Percentile)	30.88 (25.18)	5	90	50.0	12.8
Graded Naming Test (scaled score)	8.1 (4.0)	0	17	10 (3.0)	20.9
Rivermead Behavioural Memory Test (profile score, Max = 24)	15.9 (6.3)	0	24	22.19 (1.94)	80.4
Test of Everyday Attention 1-min Map Search Score (scaled score)	5.82 (4.2)	0	16	10.0 (3.0)	48.8
Test of Everyday Attention 2-min Map Search Score (scaled score)	5.9 (3.6)	0	15	10.0 (3.0)	44.8
Speed of Information Processing Test (scaled score)	7.2 (3.39)	0	18	10.0 (3.0)	32.2
Visual Object and Space Perception Battery Shape detection (Max = 20)	19.4 (0.9)	16	20	19.9 (0.33)	0
Visual Object and Space Perception Battery Incomplete letters (Max = 20)	19.3 (1.1)	12	20	19.3 (0.8)	2.2
Visual Object and Space Perception Battery Cube analysis (Max = 10)	9.6 (1.1)	2	10	9.3 (1.2)	4.4

https://doi.org/10.1017/S1355617703960127 Published online by Cambridge University Press

Table 3. Number of participants using particular memory aids/strategies, mean efficacy rating, and proportion of those rated as independent or nonindependent using each aid/strategy

Remembering strategy	Number (percentage) of whole sample using the strategy	Mean efficacy rating[b]	Proportion of those rated as independent using the strategy	Proportion of those rated as not independent using the strategy
Wall calendar/wall chart	68 (72.3)	2.35	75.0	64.0
Notebook	60 (63.8)	2.47	63.6	60.0
List[a]	59 (62.8)	2.72	72.7	50.0
Appointment diary	51 (54.3)	2.53	63.6	46.0
Asking others to remind[a]	46 (48.9)	2.73	59.1	38.0
Mental retracing	45 (47.9)	2.21	43.2	46.0
Alarm clock (wake up)[a]	38 (40.4)	2.74	54.6	26.0
Objects in unusual places[a]	33 (35.1)	2.52	47.7	24.0
Notes in special places[a]	32 (34.0)	2.64	47.7	20.0
Repetitive practice	28 (29.8)	2.21	27.3	32.0
Writing on hand	23 (24.5)	2.63	29.6	18.0
Making associations	20 (21.3)	2.00	27.3	16.0
Watch with date/timer	17 (18.1)	2.79	18.2	16.0
Daily routine	17 (18.1)	2.83	18.2	16.0
Personal organizer	16 (17.0)	2.59	20.5	12.0
Journal	15 (15.9)	2.50	9.1	20.0
Daily timetable	14 (14.9)	2.46	15.9	14.0
Alarm clock/timer	9 (9.6)	2.77	15.9	6.0
Visual imagery	9 (9.6)	2.00	11.4	8.0
Weekly routine	9 (9.6)	3.00	6.8	14.0
Alphabetic searching	7 (7.4)	2.43	6.8	6.0
Electronic organizer	7 (7.4)	2.83	13.6	2.0
TV guide (annotated)	7 (7.4)	2.74	4.5	10.0
Pill box with day/time	6 (6.4)	2.83	11.4	2.0
First letter mnemonics	5 (5.3)	2.75	0	8.0
Pager	5 (5.3)	2.75	4.6	6.0
Recipe cards or book	5 (5.3)	2.80	2.3	8.0
Pleasantness rating	3 (3.2)	2.33	4.6	2.0
Key chain	3 (3.2)	3.00	4.6	2.0
Pocket phone book	3 (3.2)	3.00	4.6	2.0
Mobile phone	3 (3.2)	3.00	6.8	0
Dictaphone/tape recorder	2 (2.1)	2.00	0	4.0
Rhymes	2 (2.1)	2.00	0	4.0
Knot in handkerchief	2 (2.1)	1.00	2.3	2.0
Orientation of medication	2 (2.1)	3.00	2.3	0
Dictionary	2 (2.1)	3.00	0	4.0
Chunking	1 (1.1)	2.00	2.3	0
Information on key ring	1 (1.1)	3.00	0	2.0
Home filing system	1 (1.1)	3.00	0	2.0
Home accounts	1 (1.1)	3.00	2.3	0
Instructions for work on wall	1 (1.1)	3.00	2.3	0
Organizer handbag	1 (1.1)	3.00	0	2.0
Buying small quantities	1 (1.1)	2.00	0	2.0
Clock calendar combination	1 (1.1)	3.00	0	2.0

[a]Those strategies for which there was more than 20% difference in usage by the independent *vs.* nonindependent groups.
[b]1 = Rarely effective, 2 = sometimes effective, & 3 = usually effective.

suggest that the most widely used aids (e.g., wall calendars, notebooks) are not necessarily the most effective, at least as judged by carers. Although caution is necessary, some aids/strategies appear to be used by a smaller number of participants, but apparently to good effect (e.g., electronic organizers, daily and weekly routines).

Number of External and Internal Aids/Strategies Used Before and After Brain Injury

The mean number of aids used before injury was 2.45, which contrasts strikingly with the mean used after brain injury,

https://doi.org/10.1017/S1355617703960127 Published online by Cambridge University Press

which was 6.8. This difference was statistically significant ($t = -13.66$; $df = 93$, $p < .0001$). Most people reported using only one memory aid before their injury and 15 participants reported that they had not used any strategies at all prior to their injury. Only eight reported using six or more aids premorbidly, one of whom apparently utilized 15 strategies. Postinjury, the modal number of aids reported was 8.

Analysis of the Relationship Between Use of Memory Aids/Strategies and Independence

In Wilson and Watson's (1996) analysis of Wilson's (1991) data, they found that independence was associated with the use of six or more compensatory memory aids and strategies. We repeated this analysis with the present sample. Independence was defined as being in paid employment, full-time education, living alone, or taking a major role in running household/caring for children. In the present sample 44 participants (46.8%) met the criteria for independence, with 50 participants (53.2%) not reaching the criterion. A chi-squared analysis revealed a significant relationship between independence and the use of six or more compensatory memory aids/strategies ($\chi^2 = 5.87$, $p = .015$), thus replicating Wilson and Watson's (1996) finding. We also examined whether independence was related to the use of less than six aids by systematically comparing whether independence was related to the use of (1) five or more aids *versus* less than five, (2) four or more aids *versus* less than four, (3) three or more aids *versus* less than three, and (4) two or more *versus* less than two. Chi-squared analysis revealed that independence was related to the use of five or more aids ($\chi^2 = 6.156$, $p = .013$), four or more aids ($\chi^2 = 5.02$, $p = .025$), and three or more aids ($\chi^2 = 6.656$, $p = .01$), but not two or more aids ($\chi^2 = 1.798$, $p = .180$). These results highlight further the relationship between use of memory aids and independence in people with memory impairment. One interpretation of the data is that a minimum of three aids is required to support independent living, though a causal relationship cannot be assumed. A further question arises as to whether particular aids are more likely to be used by those people who are classified as independent. Table 3 shows the proportion of people classified as independent or not using each of the memory aids/strategies. The general picture, reflecting the relationship between use of aids and independence documented above, is that the group classified as independent make more use of aids than the dependent group. Five aids were used by at least 20% more of the independent group than the dependent group. They were (1) an alarm clock to wake up, (2) leaving notes in special places, (3) leaving objects in special places so as not to forget them, (4) lists, and (5) asking others to remind you of something.

Analysis of Factors in Relation to Use of Memory Aids/Strategies

Wilson and Watson (1996) found that a number of factors related to whether or not individuals used six or more memory aids/strategies. The same dichotomous variables were examined using a chi-squared statistic in the present study. Our previous analysis had shown that there was a relationship between independence and use of as few as three or more aids. We therefore also examined whether there was a relationship between the factors identified by Wilson and Watson (1996) and the use of three or more aids. The variables examined were as follows:

1. Age—being less than 30 years at the time of injury.
2. Gender.
3. Severity of memory impairment—RBMT score greater than, less than, or equal to 3.
4. Absence of marked additional cognitive deficits—presence of additional cognitive deficits defined as scoring below the 5th percentile on any of the additional cognitive tests administered.
5. Absence of marked executive deficits—presence of marked executive deficit defined as having a score on the DEX-Other of greater than 40 *and* a (DEX-Other − DEX-Self) score of greater than 20. These levels were chosen to reflect the combination of high levels of emotional, motivational, behavioral and cognitive problems and a lack of insight into these problems that characterize a marked executive dysfunction (Burgess et al., 1998).
6. Level of premorbid IQ—above average premorbid IQ defined as NART estimated premorbid IQ of greater than 110.
7. Diagnosis of traumatic brain injury (TBI).
8. Less than 3 weeks coma.
9. Five or more aids used premorbidly.
10. Using at least two more aids now than premorbidly.
11. Undergone inpatient rehabilitation.
12. Undergone postacute specialist rehabilitation.

Table 4 provides the summary statistic for each of these variables. In the present study, severity of memory impairment was related to use of six or more aids in that the more severely impaired participants were using fewer memory aids, though this relationship did not hold for the use of three or more aids. Participants with marked additional cognitive difficulties were also likely to be using less than six memory aids. Those participants who had used five or more aids before their injury were more likely to be using six or more aids postinjury. On this occasion, age and the absence of an executive deficit did not appear to be related to the use of six or more aids. With regard to rehabilitation, 65 participants (69.1%) had undergone some form of acute inpatient rehabilitation and 54 participants (57.5%) had undergone some form of postacute rehabilitation. However, whether or not participants had undergone rehabilitation did not predict whether or not they were using six or more, or indeed three or more strategies (though the relationship

https://doi.org/10.1017/S1355617703960127 Published online by Cambridge University Press

Table 4. Relationship between a range of factors and whether or not participants were using six or more or three or more memory aids/strategies

Variable	Significant in Wilson and Watson (1996)?	Present study (six or more aids *vs.* less than six aids)	Present study (three or more aids *vs.* less than three aids)
Age (<30 at time of insult)	Yes	n.s.	n.s.
Gender	No	n.s.	n.s.
RBMT (screening score >3)	**Yes**	**$\chi^2 = 6.73$, $p = .01$**	n.s.
Absence of marked cognitive deficits	**Yes**	**$\chi^2 = 5.08$, $p = .02$**	n.s.
Absence of marked executive deficit	**Yes**	n.s.	n.s.
Above average pre-morbid IQ	No	n.s.	n.s.
Diagnosis of TBI	No	n.s.	n.s.
Less than 3 weeks coma	No	n.s.	n.s.
Five or more aids used premorbidly	**Yes**	**$\chi^2 = 4.76$, $p = .03$**	n.s.
Using at least 2 more aids now than premorbidly	**Yes**	n.s.	**$\chi^2 = 21.05$, $p < .001$**
Acute inpatient rehabilitation	—	n.s.	n.s.
Postacute specialist rehabilitation	—	n.s.	n.s.

Note. n.s. = not significant.

with the use of three or more aids was approaching significance: $\chi^2 = 3.374$, $p = .066$).

Analysis of the Relationship Between Five Additional Variables and Use of Memory Aids/Strategies

The analysis described above replicated the analysis undertaken by Wilson and Watson (1996). In the present study, however, a number of other variables were examined. As discussed in the Introduction, we predicted that that these variables might have a significant impact on the use of memory aids/strategies and again examined the relationship between the five factors and (1) the use of six or more aids/strategies and (2) the use of three or more aids/strategies. These variables were as follows:

- Current age.
- Time since injury.
- Current general intellectual ability (as measured by performance on Raven's Standard Progressive Matrices).
- Attentional skills (as measured by performance on the Test of Everyday Attention Map Search, 2-min scaled score).
- Mood (as measured by score on the GHQ 12).

As these are continuous variables, *t*-test analysis was performed on the mean scores from the group of participants using six or more memory aids/strategies *versus* the group using less than six strategies and the group of participants using three or more memory aids/strategies *versus* the group using less than three strategies. All of the above variables were found to be related to level of memory-aid usage. Thus, the participants who used six or more memory aids were younger ($t = 3.04$, $p = .003$), were more recently injured ($t = 3.113$, $p = .002$), had a higher current intellectual ability ($t = -3.07$, $p = .003$), and better attentional skills ($t = -2.12$, $p = .04$). Participants who made more use of six or more memory aids were also those that had a higher level of subjective distress on the GHQ ($t = -2.12$, $p = .04$). This finding was somewhat unexpected. We anticipated that participants with a higher level of mood disorder would be less motivated to use memory aids and strategies. One explanation for this result is that participants experiencing most distress were those with greater insight into their difficulties and thus most aware of their limitations and the need to compensate. This issue was explored further in a number of ways. Firstly, clients' level of subjective complaints on the EBIQ was examined in relation to the extent that they use memory aids/strategies. A comparison of total score on the EBIQ was made between those participants who used less than six aids and those who used six or more aids. This analysis revealed that the use of six or more aids was associated with a higher level of subjective complaint on the total EBIQ score ($t = -2.728$, $p = .008$). Relatives/carers ratings on the EBIQ were also examined, but there was no relationship between these and whether or not individuals were using six or more strategies ($t = -1.195$, $p = .236$). The issue of insight or lack of it is typically viewed as part of the dysexecutive syndrome. It was noted above that there was no apparent relationship between the presence of executive dysfunction and the use of six or more aids. This was explored further by looking at whether or not the presence, or absence, of a dysexecutive syndrome was associated with the total number of memory aids used and the number of memory aids used by the participants that were rated by relatives as effective. Here there was found to be an association between executive dysfunction and total number of memory aids rated as effective ($t = -2.00$, $p = .049$), but not the total number of

https://doi.org/10.1017/S1355617703960127 Published online by Cambridge University Press

aids used ($t = -0.335$, $p = .738$). These results would therefore seem to indicate that the level of dysexecutive impairment does affect whether or not clients use memory aids effectively.

The participants who used three or more aids/strategies were younger ($t = 2.87$, $p = .005$), had a higher current intellectual ability ($t = -3.45$, $p = .001$) and better attentional skills ($t = -2.582$, $p = .012$), but for this group there was no difference with the participants who used less than three aids in terms of time since injury or level of subjective distress.

Regression Analysis Examining Which Factors Best Predict Use of Memory Aids/Strategies

The analyses described above indicated that several variables were related to the level of use of memory aids/strategies. The next analysis examined the question of what combination of these variables best predicted use of aids/strategies. Because the sample size for this study was considerably larger than that for the Wilson and Watson (1996) study, we were able to use a regression technique for the analysis. The dependent variable used for this analysis was the number of memory aids used that were rated by relatives as "usually" effective. This measure was adopted as our main interest was in predicting *effective* use of aids, not just overall use of aids that may or may not be effective for the individual. This measure was also shown to be related to the level of independence of the participants; *t*-test analysis on the number of effective aids used by those classified as independent, contrasted with those classified as not independent, was significant ($t = 2.387$, $p = .019$). The independent variables chosen to include in this analysis were those that had been found to relate to use of aids/strategies in the analyses from the present study or that of Wilson and Watson (1996). Thus, the variables entered into a stepwise multiple-regression analysis were as follows:

1. Current age.
2. Time since injury.
3. Age at injury.
4. Number of aids used premorbidly.
5. General Health Questionnaire (GHQ—mood/general health rating).
6. Raven's Standard Progressive Matrices (RSPM—current intellectual functioning).
7. Test of Everyday Attention Map Search scaled score (TEA—selective attention/speed).
8. Rivermead Behavioural Memory Test profile score (RBMT—current memory).
9. Dysexecutive Syndrome Questionnaire (DEX—carer rating).
10. European Brain Injury Questionnaire Total Score (EBIQ—self ratings).

For this analysis, we used the RBMT profile score rather than screening score as this score is more sensitive to variations in performance. We used the DEX carer rating as this has been shown to be a more reliable estimate of executive dysfunction (Wilson et al., 1996). For the EBIQ and GHQ, however, we decided to use the self-ratings since these measures are primarily concerned with perceptions of psychosocial symptoms. Given that our interest was in possible relationships between mood/psychosocial factors and use of aids, we considered it more appropriate to use self-ratings.

The result of the regression analysis was that the following variables remained in the regression equation; current age, time since injury, number of aids used premorbidly, and the Test of Everyday Attention Map Search (2 min) scaled with an r^2 of .313 and adjusted r^2 of .274). This result suggests that although all of the ten variables explored in the analysis had been shown, when considered independently, to have a relationship with the number of memory aids used by participants, a combination of just four of them provide the best prediction with regard to use of memory aids by the participants in this study. The regression model equation was: Number of aids used effectively = 5.307 + (.227 × number of aids used premorbidly) + (.133 × TEA 2-min Map Search scaled score) − (.130 × years since injury) − (.004 × current age).

We were also interested in examining the extent to which this combination of variables also predicted whether or not participants used six or more aids (the original Wilson and Watson variable) and whether or not participants used three or more aids (which was shown in our current analysis also to relate to independence). Logistic regression showed that the combination of current age, number of aids used premorbidly, TEA 2-min Map Search Scaled Score, and time since injury did also significantly predict group membership (six or more aids *vs.* less than six aids, −2 log likelihood 74.773, $\chi^2 = 34.543$, $p < .0001$, overall correct classification of group membership of 81.61%; three or more aids *vs.* less than three aids, −2 log likelihood 20.439, $\chi^2 = 23.237$, $p = .0001$, overall correct classification of group membership of 93.10%).

DISCUSSION

This study surveyed the use of memory aids and strategies in a sample of almost 100 people with acquired brain injury who experience memory problems on a day-to-day basis. The study sample was representative of the population of people with acquired brain injury, having a wide range of causes of injury, age, occupation, and premorbid experience with memory aids. There are several major findings. The first was that a great number of different strategies, 44 to be precise, are being employed by people with brain injury to support impaired memory. Almost everyone in the sample was using at least one memory aid or strategy. While

https://doi.org/10.1017/S1355617703960127 Published online by Cambridge University Press

that is not unexpected, in that most of the nonbrain injured population probably use at least one memory aid, the participants in this study were using considerably more memory aids/strategies than they used premorbidly. The most commonly used memory aids were external aids such as calendars, lists, notebooks, and diaries. This is a similar finding to the long-term follow-up study reported by Wilson (1991). The data derived from efficacy ratings highlighted the fact that the most widely used aids/strategies were not necessarily considered to be the most effective, while some aids being used by a smaller number of participants were considered to be more effective. As noted earlier, caution is required in interpreting mean data when only a small number of participants were involved. Furthermore it is possible that the raters may have been less inclined to rate an aid as "rarely effective", just because the aid was being used at all, but the use of carers for the rating may have reduced this problem somewhat.

Of particular interest was the finding that a very small number of people were using electronic aids. Such systems have much of the functionality that might be considered to be important for the memory-impaired person (e.g., calendar, schedule, to-do list, memos, and address/phone numbers). In particular, they have the major advantage of being able to deliver timed alarms to remind the individual of particular tasks or simply to act as a reminder to check the aid for things that may need to be done. We did not examine in this study reasons for not using such aids and this would be an important focus of future research. However, we speculate that there are several reasons for the lack of uptake of such aids. The most likely explanation is that such aids are too complex for most people with significant memory or other cognitive impairments to be able to learn how to use. Furthermore, it is possible that such aids are not being routinely recommended during the course of rehabilitation. This highlights the need for further development of either new systems or modified versions of currently available electronic aids (Wright et al., 1997a,b, 2001). It also highlights the need for those working in rehabilitation settings to develop a good working knowledge of the electronic aids that are currently available (e.g., Wilson et al., 2001), and also the most effective methods for teaching people with memory impairments how to use these aids.

The present study replicated Wilson and Watson's (1996) finding that there was a relationship between the use of memory aids and level of independence. The finding of a relationship between independence and the use of six or more aids was replicated, but in the present study there was also a relationship between the use of as few as three or more aids and independence. This relationship is not necessarily causal (i.e., one cannot conclude that using memory aids makes the memory-impaired person independent), but it is consistent with the view that being independent, in the context of a memory impairment, demands the use of memory aids. In clinical practice, it is often the case that there is something of a "chicken and egg" situation with regard to use of memory aids and level of independence; people with little independence often have very little to remember to do, possibly because they are not given responsibility for remembering things because of their unreliable memory. In effect, there is no need for a memory aid because there is nothing to remember. In contrast, the person who is independent is, by definition, taking responsibility for remembering several, if not many, things every day and so the need for a memory aid is more obvious. This point may also account for some of the findings concerning those memory aids/strategies that are used to a greater extent by those people classified as independent. For example, the finding that more of the independent group used an alarm clock to wake them up may reflect a greater need to be up at a particular time (e.g., for work or family responsibilities). Similarly, the higher level of use of lists by the independent group may reflect greater activity levels and hence greater need for lists (e.g., of things to do).

Wilson and Watson (1996) identified a number of factors that appeared to be related to the use of memory aids (or more specifically whether or not they used six or more aids). They found that age at the time of injury, level of memory impairment, absence of additional cognitive impairment, absence of marked executive deficit, whether or not participants used five or more aids premorbidly, and whether or not they were using at least two more aids than premorbidly all related to use of six or more aids. In the present study with a larger group of participants, we found that the level of memory impairment, the absence of additional cognitive impairments, and whether or not individuals were using more than five aids premorbidly again predicted use of six or more aids/strategies. Age at the time of injury and the absence of marked executive deficits did not predict whether or not people used six or more strategies, but did relate to the number of aids described as effective. Several other variables were also shown to relate to the use of six or more aids including current age, level of intellectual functioning, attentional skills, and mood/health state perception. When the dependent variable was whether or not participants used three or more aids, age, general intellectual ability, and attentional skills were significant.

The present study found no relationship between rehabilitation and the level of memory-aid usage, something that may disappoint rehabilitationists. This finding can be interpreted in a number of ways, though it is not obvious from the data which is the more likely explanation. One possibility is that formal rehabilitation is not effective in influencing whether memory aids are used and, if so, which ones. An alternative is that many rehabilitation services do not teach the use of such aids or do not teach effective use of such aids to a sufficient extent and that this could and should play a larger part in rehabilitation interventions.

Overall, ten of the variables explored in this study predicted use of memory aids when examined independently. However, a group of just four variables remained in a multiple-regression model. These were (1) current age, (2) time since injury, (3) number of aids used premorbidly,

and (4) Test of Everyday Attention Map Search scaled score. These are discussed in turn below.

Age

In this sample, the younger the person (either at the present time or at the time of injury), the more likely is the use of memory aids. It is not clear what accounts for this relationship, though one could speculate that the younger individual may be more likely to be looking to return to work or increasing independence and perhaps have a more flexible approach to learning to adjust to a memory impairment. It does suggest that greater rehabilitation effort should be targeted at the older person with a memory impairment.

Time Since Injury

For this sample, the longer the time since the injury the less memory aids were being used. In apparent contrast, Wilson (1991) commented that it appeared that the participants in her study did not use aids immediately (following discharge from a rehabilitation program), but began doing so after some time elapsed. It is possible of course that this statement could still have applied to the present group in that, postdischarge from rehabilitation, individuals may have gradually increased the number of aids used, but then over time this number decreased. It might be argued that individuals would "try out" a number of different aids, before settling on a limited number that prove to be most useful. Evans and Wilson (1992) reported this pattern over the course of a memory group. A more negative interpretation is that over time the lack of opportunity for work or greater independence, problems that often accompany brain injury, leads to an initial enthusiasm (or need) for using memory aids to wane over time. This highlights the need for effective postacute rehabilitation and long-term follow-up to support the initial development and maintenance of the use of aids.

Number of Aids Used Premorbidly

The finding of a relationship between the premorbid and postmorbid level of use of memory aids is unsurprising. It is a common experience for clinicians and therapists to have more difficulty persuading people who have never previously relied upon any sort of memory aid, such as a diary, to start using one. For rehabilitation, the implication is that it is important to take a good memory-aid history from a patient and where appropriate to build on premorbid experience. For the person who has not relied on memory aids, more effort may need to be made to develop an appreciation of the value of using memory aid and in the careful selection of aids, which may change over time.

Attention (Test of Everyday Attention Map Search Scaled Score)

A measure of attention and speed of information processing proved to have a strong relationship with the use of memory aids. This highlights the importance of impairments of attention in the recovery and adaptation process after brain injury. Robertson et al. (1997) found that measures of attention taken early poststroke predicted later levels of functional recovery. They suggested that the presence of attentional deficits will interfere with the ability to learn ways of compensating for persisting deficits and this will limit recovery of functional ability. The same argument would seem to apply to learning to use memory aids.

In summary, this study has replicated the finding of Wilson and Watson (1996) that the use of memory aids is associated with greater levels of independence. Furthermore, it has shown that a diverse range of memory aids and strategies are in use. The majority of people with memory impairments are using at least one aid/strategy. However, only a small percentage are using multifunctional aids such as Filofax or electronic aids, despite their apparent utility as remembering systems. With regard to predicting use of memory aids/strategies the people who appear to be making most use are those who are younger and more recently injured. They are also people with premorbid experience of using such aids and with better attentional skills. Whether or not people had undergone rehabilitation did not appear to be a significant factor in predicting memory-aid usage. There are several possible implications of this study. One is that rehabilitation services should place a greater emphasis on teaching people with memory impairments to use aids and strategies. However, people who are older, longer postinjury, have little premorbid experience of such aids and poor attention will need much greater levels of support in learning to use such aids. There should perhaps be a greater emphasis on teaching the use of multifunctional, electronic aids (where appropriate). There may also be a need to design new memory aids that meet the remembering demands of people with memory impairments, but which are simple enough to learn despite the presence of attention, memory, and/or executive dysfunction.

One of the potential limitations of this study is that the *number* of memory aids (or for some analyses the number of effective aids) was used as the measure of memory-aid/strategy use. One might speculate that an individual using just one multifunctional aid (such as a Filofax or electronic organizer) might be functioning the most efficiently. On the other hand, as has already been noted, very few of the participants were actually using such multifunctional aids. For this study, therefore, the number of aids may be a reasonable measure of memory-aid use. However, any future studies of this issue might need to consider using an alternative measure such as a relative or therapist rating of the global effectiveness of memory-aid usage. A related limitation of this study was reliance on questionnaire and interview data. We relied primarily on information provided by relatives or significant others because of the well-documented difficulty with insight and awareness experienced by people with brain injury. However, this meant that we were sometimes relying on information from a person who may not always have been in a position to observe memory-aid use.

https://doi.org/10.1017/S1355617703960127 Published online by Cambridge University Press

For information relating to premorbid memory-aid usage, we also relied on a consensus view, for which, like the other measures, reliability is impossible to verify. The key questions were whether the use of memory aids is related to levels of independence after brain injury and what factors predict use of memory aids. In further studies, consideration needs to be given to identifying more objective measures of memory-aid usage. With electronic devices this is possible—in a recent study (Wright, et al., 2001) we used data-logging technology to record all use of an electronic memory aid and this proved helpful in identifying the pattern of use of the aid. Furthermore, combining such data-logging technology with other measures of intended task completion would be a better way of exploring the relationship between memory-aid use and functional independence.

ACKNOWLEDGMENTS

Funding for this project was awarded by the NHS Executive Eastern Region Office. We would like to thank all of the participants in this project who kindly took the time to take part. We are also grateful to the staff at Headway Cambridge, Agnes Sheil, Vanessa Garfoot, and Alex Goody who put us in touch with participants in their areas. We are grateful to four anonymous reviewers for their thoughtful comments on this paper.

REFERENCES

Baddeley, A.D., Emslie, H., & Nimmo-Smith, I. (1992). *Speed and capacity of Language Processing Test*. Flempton, England: Thames Valley Test Company.

Berg, I.J., Koning-Haanstra, M., & Deelman, B.G. (1991). Long term effects of memory rehabilitation: A controlled study. *Neuropsychological Rehabilitation, 1*, 91–111.

Burgess, P., Alderman, N., Evans, J.J., Emslie, H., & Wilson, B.A. (1998). The ecological validity of tests of executive function. *Journal of the International Neuropsychological Society*, *4*, 547–558.

Evans, J.J. & Wilson, B.A. (1992). A memory group for individuals with brain injury. *Clinical Rehabilitation*, *6*, 75–81.

Glisky, E.L. (1995). Computers in memory rehabilitation. In A.D. Baddeley, B.A. Wilson, & F. Watts (Eds.), *Handbook of memory disorders*. Chichester, New York: Wiley.

Goldberg, (1972). *The detection of psychiatric illness by questionnaire*. Oxford, England: OUP.

Kapur, N. (1995). Memory-aids in the rehabilitation of memory disordered patients. In A.D. Baddeley, B.A. Wilson, & F. Watts (Eds.), *Handbook of memory disorders*. Chichester, New York: Wiley.

McKenna, P. & Warrington, E.K. (1983). *The Graded Naming Test*. Windsor, England: NFER.

Nelson, H. & Willison, J. (1991). *The National Adult Reading Test* (2nd ed.) Windsor, England: NFER.

Raven, J.C. (1976). *Standard progressive matrices*. Oxford, England: Oxford Psychologists' Press.

Robertson, I., Ward, A., Ridgeway, V., & Nimmo-Smith, I. (1994). *The Test of Everyday Attention*. Flempton, England: Thames Valley Test Company.

Robertson, I.H., Ridgeway, V., Greenfield, E., & Parr, A. (1997). Motor recovery after stroke depends on intact sustained attention: A two-year follow-up. *Neuropsychologia*, *11*, 290–295.

Robertson, I.R. (1999). Setting goals for rehabilitation. *Current Opinion in Neurology*, *12*, 703–708.

Teasdale, T.W., Christensen, A.L., Willmes, K., Deloche, G., Braga, L., Stachowiak, F., Vendrell, J.M., Castro-Caldas, A., Laaksonen, R.K., & Leclercq, M. (1997). Subjective experience in brain injured patients and their close relatives: A European brain injury questionnaire study. *Brain Injury*, *11*, 543–563.

Warrington, E.K. & James, M. (1991*). The Visual Object and Space Perception Test*. Flempton, England: Thames Valley Test Company.

Wilson, B.A. (1991). Long term prognosis of patients with severe memory disorders. *Neuropsycholgical Rehabilitation*, *1*, 117–134.

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

Wilson, B.A., Cockburn, J., & Baddeley, A.D. (1985). *The Rivermead Behavioural Memory Test*. Flempton, England: Thames Valley Test Company.

Wilson, B.A., Alderman, N., Burgess, P., Emslie, H., & Evans, J.J. (1996). *Behavioural assessment of the Dysexecutive Syndrome*. Flempton, England: Thames Valley Test Company.

Wilson, B.A., J.C., & Hughes, E. (1997a). Coping with amnesia: The natural history of a compensatory memory system. *Neuropsychological Rehabilitation*, *7*, 43–56.

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

Wilson, B.A., Emslie, H., Quirk, K., & Evans, J.J. (2001). Is Neuropage effective in reducing everyday memory and planning problems? A randomised control crossover study. *Journal of Neurology, Neurosurgery and Psychiatry*, *70*, 477–482.

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