SHORT REPORT

Evaluation of NeuroPage: a new memory aid

Barbara A Wilson, Jonathan J Evans, Hazel Emslie, Vlastimil Malinek

Abstract

This report describes NeuroPage, a simple and portable paging system, developed in California by the engineer father of a son with head injury working together with a neuropsychologist. Using an ABA single case experimental design, the efficacy of NeuroPage was evaluated with 15 neurologically impaired subjects all of whom had significant everyday memory problems because of organic memory impairment or because of problems with planning and organisation consequent on frontal lobe damage. Data were analysed with an odds ratio test which takes into account different underlying success rates for each target and calculates an average improvement factor. This test showed a significant improvement between the baseline and the treatment phases for each subject (P<0.05).

(*J Neurol Neurosurg Psychiatry* 1997;**63**:113–115)

Keywords: memory; brain injury; rehabilitation

MRC Applied Psychology Unit, Cambridge
B A Wilson
H Emslie
V Malinek

Oliver Zangwill Centre, Ely
J J Evans

Correspondence to:
Dr B A Wilson, MRC Applied Psychology Unit, Rehabilitation Research Group, Box 58, Addenbrooke's Hospital, Hills Road, Cambridge, CB2 2QQ, UK.

Received 24 September 1996 and in revised form 5 March 1997
Accepted 6 March 1997

Various strategies are employed to alleviate or compensate for memory disorders. These include environmental adaptations, memory games and exercises, mnemonics, and external memory aids. The last are probably the most useful for the greatest number of people and the most likely to be used in the long term by people with brain injury.[1] Unfortunately, using external aids efficiently involves memory so the very people who need them most have the greatest difficulty using them. People with impaired memory have problems with compensatory aids because they (*a*) forget to use them; (*b*) are unable to programme them; (*c*) use them in an unsystematic way, and (*d*) are often embarrassed by them. Over time, frustration, psychosocial disruption, and financial strain caused by some or all of these difficulties can overwhelm brain injured people and their families.

Within the past few years a neuropsychologist and an engineer, who is also the father of a son with head injury, have developed NeuroPage[2] to overcome these difficulties. NeuroPage is a simple and portable paging system with a screen that can be attached to a belt. The system uses an arrangement of microcomputers linked to a conventional computer memory and, by telephone, to a paging company. The scheduling of reminders or cues for each person is entered into the computer and from then on no further human interfacing is necessary. On the appropriate date and time NeuroPage accesses the user's data files, determines the reminder to be delivered, and transmits the information.

Users of NeuroPage can control the device with one rather large button, easy to press even for those with motor difficulties. It avoids most of the problems of existing aids such as cumbersome computers or very small watch alarms because it is highly portable and has an audible alarm that can be adapted to vibrate if required, together with an accompanying explanatory message. It is not embarrassing for most users and indeed would seem to convey prestige. We wanted to determine the efficacy of NeuroPage for reducing everyday memory problems for people with neurological impairments.

Subjects and method

Twenty subjects with organic memory problems were referred for advice on management of their memory difficulties from various sources including the neurology department at Addenbrooke's Hospital (Cambridge), local therapists, clinical psychologists, and the local branch of the National Head Injuries Association (Headway). Of these, 15 were included in the study. Time after insult ranged from six months to 13 years with one subject having had a second subarachnoid haemorrhage two weeks earlier. Of the remaining five, one subject withdrew believing that he did not have memory problems, one subject and his wife refused (or were unable) to keep baseline data, two subjects were totally dependent on their families and were considered unsuitable as they did not need to carry out activities independently, and one subject did not complete the intervention phase as the main targets related to her moving to a new flat and this has been delayed. The table shows the diagnoses of the 15 subjects together with age, sex, and other details. Most (12) subjects were living at home with their families, one subject was living alone, one was in long term residential care, and one in an acute hospital at the start of the trial, and living alone after discharge. None of the subjects were in paid employment, although

Table 1 Mean % success rates before, during and after treatment and with improvement factor estimates identified from the OR test[2]

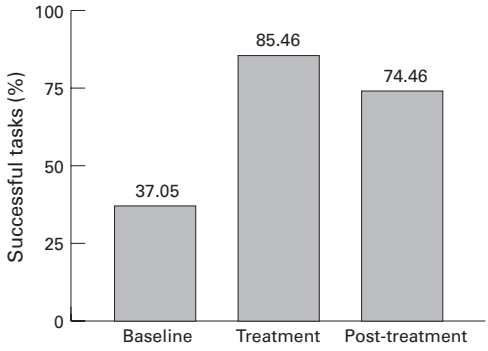
Subject	*Age*	*Sex*	*Diagnosis*	*Number of problems*	*% Success baseline*	*% Success NeuroPage*	*Improvement factor estimate between baseline and treatment*	*% Success after baseline*	*Improvement factor estimate between baseline and after baseline*
1	46	M	Colloidal cyst	5	6.67	22.93	6.8*	16.43	5.5^{BL}
2	43	M	HI	5	24.29	66.94	11.0*	60.71	9.9^{BL}
3	24	F	HI	7	45.80	99.86	21.86*	98.64	22.36*
4	50	F	CVA	5	55.56	91.19	14.3*	71.95	1.8^{NS}
5	66	M	SAH	4	13.33	88.02	90.8*	86.90	49.7*
6	21	M	HI	4	14.29	73.21	19.4*	88.10	62.1*
7	63	M	HI	3	48.68	77.65	3.8*	79.06	4.1*
8	36	M	HI	2	79.17	95.78	8.7*	84.76	1.0^{NS}
9	29	M	HI	5	4.17	84.14	23.01	0.00	0^{ns}
10	19	M	HI	4	28.57	91.79	30.8*	87.50	25.1*
11	30	M	HI	3	61.59	94.77	15.4*	69.68	1.3*
12	19	F	HI	2	66.67	94.44	11.1*	86.67	3.2*
13	57	M	HI	4	64.23	89.14	5.7*	86.61	22.0*
14	51	F	Tumour	4	43.21	84.27	9.1*	100	00*
15	47	M	SAH	1	0.00	99.32	00*	100	00*

* P<0.05 (two tailed test).
HI = head injury; BL = borderline; CVA = cerebral vascular accident; SAH = subarachnoid haemorrhage.

one was trying to run his own business from home, two subjects were attending sheltered workshops, and two were at college. All subjects were assessed on the Rivermead behavioural memory test[3] and showed a range of scores with some scoring in the severely impaired range and others in the moderate or mildly impaired range. Nevertheless all subjects showed everyday memory problems in the diary and baseline phases. Memory failures can of course, occur for other reasons such as poor attention, planning, and organisational skills.

We used an ABA design to evaluate the success of NeuroPage. The first A phase was the baseline, the B phase was for treatment, and the second A phase was the post-treatment baseline. Before the first baseline phase began, potential subjects were interviewed with a close relative or carer, the purpose of the study was explained, and subjects were asked to complete a memory diary for a one to two week period. The purpose of the diary was to identify practical real life problems. After further discussion, some of these problems were selected for treatment. The mean number of problems selected was 3.86 (SD 1.45; range 1-7). The commonest reminders were (1) good morning, it is (day, date); (2) take your medication now; (3) fill in your diary; (4) don't forget to take your (keys/bag/stick/folders, etc), and (5) make your packed lunch.

Baselines were taken on the memory failures for a two to six week period. We needed to ensure baselines were stable before introducing the pager, hence the variability in baseline length. The nature of the baselines depended on the particular problem. So, for example, remembering to take medication was usually recorded as "number of minutes late"; remembering to attend a clinic was recorded as "yes" or "no"; and remembering to switch off a number of appliances every day was recorded as "percentage of appliances remembered". In the B phase (treatment) data were collected for 12 weeks. Reminders for the targeted problems were sent out at times agreed with the subject and the carer. The longer treatment phases were for those people who were on holiday or away from college for part of this period. Data were collected for 12 weeks for each subject. Success or failure was recorded in the same way as the baseline phase. In the post-baseline (second A phase), which lasted for three weeks, the pager was removed and recordings were taken to determine whether the problems reached their initial baseline levels or not.



Mean percentage of tasks completed successfully in baseline, and during and after treatment.

Results

All subjects benefited from NeuroPage. The mean % success for the whole group in the baseline phase was 37.08 (SD 24.86) and the mean success in the treatment phase was 85.56 (SD 18.58) (figure).

For some subjects (for example, subjects 9 and 15) this meant a dramatic improvement from virtually total failure to total success. For other subjects (for example, subject 1) performance was still poor overall despite being better than the baseline period. An odds ratio test,[4] which takes into account different underlying success rates for each target and calculates an average improvement factor, showed that all subjects benefited significantly from NeuroPage. The mean % success in the post-treatment phase was 74.46 (SD 28.23), showing that the group as a whole was more successful after using NeuroPage than before. However, as shown in the table, there were large variations in post-treatment performance. For some subjects (for example, subject 3), there was virtually no decline in performance after NeuroPage was withdrawn. For others (for example, subject 9), performance dropped dramatically to pretreatment values.

Discussion and conclusions

All 15 subjects benefited from the pager and showed a significant improvement in the percentage of tasks achieved. For some subjects, three months with NeuroPage was enough to establish routines. By then they were taking medication on time, drawing up lists of things to do, using checklists, and so forth, all of which were maintained when the pager was withdrawn. For others (for example, subjects 4 and 9), it would seem that NeuroPage would have to be offered on a long term basis. We suspect that this pattern of results might be explained by the presence or absence of executive deficits such as planning and organisation and we propose to test this out in a future study.

NeuroPage is a very simple to use but highly complex compensatory technique that has the potential to enhance independence and employability, speed discharge from acute and rehabilitation services, and reduce stress. Among our own subjects in the present study one young woman with head injury was able to return to college with the help of NeuroPage, another woman in the pilot study found that NeuroPage was helpful at her place of employment, and the wife of another subject was able to return to work as a nurse because she could now rely on her husband not only to get himself up in the morning, take his medication, and prepare his packed lunch before he went to his sheltered workshop, but also to rely on him waking their three small children and getting them dressed and out to school or nursery on time. NeuroPage is also likely to be cost effective for health services. For example, one of our patients was able to leave hospital a week earlier than anticipated because of improved compliance with medication once he had been issued with NeuroPage. The likelihood of readmission was also reduced. The average cost per patient per month for the pager is in the region of £50 (including hire of pager, air time, and contribution to salary of staff member running the programme). This compares well with many drug regimes and salaries for healthcare assistants.

This work was funded by a grant from the NHS National Research and Development Programme for People with Physical and Complex Disabilities. We thank Larry Treadgold and Neil Hersh for the NeuroPage software; VodaPage, Philips and Hutchison, for the loan of pagers and air time, and Ian Nimmo-Smith for help with statistics.

1 Wilson BA. Long term prognosis of patients with severe memory disorders. *Neuropsychological Rehabilitation* 1991;**1**:117–34.
2 Hersh N, Treadgold L. NeuroPage: the rehabilitation of memory dysfunction by prosthetic memory aid cueing. *Neurorehabilitation* 1994;**4**:187–97.
3 Wilson BA, Cockburn JM, Baddeley AD. *The Rivermead behavioural memory test*. Bury St Edmunds: Thames Valley Test Company, 1985.
4 Everitt B. *Cambridge dictionary of statistics in the medical sciences*. Cambridge: Cambridge University Press, 1995:181.