Comparison of pocket-computer memory aids for people with brain injury

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Two styles of pocket computer memory aid were compared as support for people who had sustained non-progressive, closed-head brain injury. A purpose-designed interface provided a diary with auditory alarms, a notebook and links between diary entries and specific notepages. One computer had a physical keyboard, the other did not. Twelve adult volunteers were loaned each computer for 2 months, with a 1 month gap between, in counterbalanced order. It was found that all participants could use the memory aids, and most (83%) found them useful. Little customizing was needed, but amount of use varied widely. Predictors of usage included use of other reminding systems before joining the project, and speed in calculator addition which may reflect working memory. High users preferred the computer with a physical keyboard; low users made more entries with the palm-size computer. These data highlight the need to distinguish ability to use from willingness to use.

Introduction

Memory aids such as diaries and address books are essential to daily life for most people. There are recent reviews of the benefits offered by many kinds of memory aids [1], and overviews of the range of electronic aids that are potentially beneficial in the context of rehabilitation after brain injury [2]. For people with cognitive impairments, conventional forms of memory support may not be enough. Paper-based aids require planning skills, which may be impaired. They also make heavy demands on memory. People must remember to enter items into the diary, then remember to look in the diary for forewarning of future activities, and remember to carry out these activities at the appropriate time. Electronic memory aids can reduce some of this memory load, e.g. by sounding an alarm when an activity needs to be done and inserting repeated entries, and so can offer assistance to people with memory problems in maintaining their independence and enhancing their quality of life.
For patients with memory loss arising from brain injury it has been established that paging systems can be highly beneficial [3]. So, too, can pocket computers [4] with the advantages of greater flexibility in changing appointments together with more scope for tailoring the look and feel of the interface to specific user needs. People who have sustained brain injury will differ in the severity of their memory loss and the impairment of other cognitive functions such as planning and organizing ability. Consequently, it is desirable that the interface of a computer-based memory aid, together with the range of functions made available, can be easily customized to suit individuals. Ways in which this might be done include simplifying how appointments and other text are entered into the aid [5]. The risk of confusion, for example between entering reminders in an appointment diary or in an electronic notebook, might be reduced by removing some of the functionality or inserting a dialogue sequence that helps the user enter information in the appropriate place. The main goal of the project reported below was to see whether an interface could be designed for memory aids on pocket computers, including an appointment diary and a notebook, that could be easily mastered by people with memory problems.

Pocket computers differ in whether or not they provide a physical keyboard. A keyboard may facilitate text entry, and so encourage greater use, or it may make the machine seem off-putting and too technical for participants with little or no experience of using computers. The alternative is to display an on-screen keyboard where letters can be tapped by a pen. This enables the computer to be smaller and lighter, but the keyboard reduces the display area of the already small screen. Entering text via these keyboards is known to be error-prone, but people may not be bothered by this when they are writing for themselves [6]. As the technologies of information and communication develop, the convergence of pocket computers and mobile phones may solve the portability problem whilst retaining the availability of the keyboard. It, therefore, is very timely to ascertain whether people with memory problems would be helped or hindered by use of a physical keyboard. This project compares people’s attitudes to and use of pocket computer memory aids when essentially the same interface is made available on a handheld computer with a keyboard and on a palm-size computer having only a touch-screen keyboard. It is difficult to predict which will be better suited for people who have sustained a brain injury.

**Method**

The comparison of the two computers was a within-subject design, with participants using each machine for 2 months, with a gap of 1 month between machines. The order of machines was counterbalanced across participants. Everyone followed a 22-week protocol, in which a memory diary was kept during week 1.

**The protocol**

On the first visit, the researcher explained the purpose of the project, discussed the memory aids currently being used, demonstrated the functionality of both computers, administered tests of visual acuity [7] and left a memory diary for daily completion. In addition, participants did a short, timed test that combined manual dexterity in using a small pocket calculator and short-term memory in entering
simple arithmetic calculations that were printed on a card. In the second visit, a week later, the researcher demonstrated the memory aids on one of the pocket computers and it was loaned to the participant. A follow-up visit took place in week 3. During a telephone interview in week 6, people were asked about their satisfaction with the computer and they were asked to use it to verify information known to be in the computer (e.g. the researcher would ask ‘What time did we say I should come on 22nd June?’). The computer was reclaimed after week 10 and participants then had 4 weeks without a machine during which they were asked to record instances when they felt they would have used the computer and whether they managed successfully without it.

When the second computer was delivered, a short selection of psychometric tests was given. These included the National Adult Reading Test (NART) [8], the Speed and Capacity of Language Processing Test (SCOLP) [9], the Rivermead Behavioural Memory Test (RBMT) [10] and the six elements subtest from the Behavioural Assessment of Dysexecutive Syndrome (BADS) [11]. These psychometric measures would enable questions to be addressed concerning the cognitive pre-requisites for benefiting from the memory aids, or the possible cognitive indicators of being unlikely to benefit. Participants were loaned their second pocket computer for 8 weeks, and the protocol of visits and telephone interviews was repeated as for the first computer. Details of actual usage were known from a time-stamped computer log file of entries made. So, it was possible to distinguish participants’ ability to use the full range of functions offered by the memory aid (performance testing), and their willingness to use specific functions (computer log).

The memory aids

The computers

Both computers had grey-scale monochrome touch screens. The computer with a keyboard was a Hewlett Packard (HP) 360 LX with 8 MB RAM, and a screen resolution of $640 \times 240$ pixels, occupying $154 \times 62$ cm in landscape orientation. The computer without a physical keyboard was a Casio E10 with 8 MB RAM, and a screen resolution of $240 \times 320$ pixels, occupying $80 \times 60$ cm in portrait orientation. In spite of these size and format differences between the screens, it was possible to display essentially the same information in a very similar format on both computer screens (see figures 1(a) and (b)).

The memory aids

Two memory aids, specifically designed for this target audience, were offered on both computers. One was an appointment diary, the other a notebook. These aids could be linked so that from a diary entry (e.g. Coffee with Alex) participants could move swiftly to the notepage containing details about Alex. This would be useful if Alex had to be contacted to rearrange the appointment, or if the diary user had forgotten who Alex was. These links were set from the diary page and could be made at any time, not only when first making the diary entry. For any diary entry, people could set an alarm to ring and tick a box to repeat that entry daily or weekly. Figure 2 shows the screen used for entering the details of an appointment into the diary. The constraint of the 16 character slot size for each appointment was
overcome by the provision of a button labelled ‘More Text’, which enabled four further slots to be displayed for the same timed appointment. The text in any extra slots was shown on the diary page. People could use indentation via the space bar to create a formatted display if they wished.

Navigation

Apart from text entry on the HP, all interactions with the memory aids were by tapping the screen with the pen provided. There were two ways of moving between diary pages. Arrows on the screen allowed people to move forward or back one page at a time for as many pages as they wished. The button ‘Other Days’ displayed a vertical list of dates for the current week in the format Mon 21 June 1999, and arrows let people move to past or future weeks. The design decision to show weeks rather than months was taken on the basis of an analysis of the frequency with which entries had been made in previous NeuroPage studies [2]. If this was found inappropriate by present participants, they would have several opportunities to request changes during the project.

The computer notebook offered free text entry, together with the option to label any page. A vertical list of labels could be displayed, and tapping a label in this list opened that page in the notebook. Labels could also be included in a ‘Short List’ accessed from a button on the start-up screen which enabled swifter access to important pages (e.g. the doctor) or any pages used often. Notepages without labels could be found by using the arrows to go through the notebook page by page.
Participants

Five people who started the project discontinued for diverse, idiosyncratic personal reasons. Three people did so after their first week with the pocket computer, all had been loaned a Casio. Two people withdrew after having a pocket computer for 8 weeks, one had an HP and the other a Casio. The data reported below came from a further 12 participants, six men and six women, with an average age of 34 years (range 22–54 years). Most had suffered traumatic brain injury, and six participants had been under 30-years-old at the time of injury. The mean duration since brain injury was 6 years (range 2–12 years). Four participants had previously used NeuroPage.

Exclusions

Exclusion criteria specified visual or motor handicaps that would have made it too difficult for the volunteer to read the screen or to tap designated areas on the display. Screening tests were conducted during the first visit. These included an assessment of visual acuity based on the Lighthouse Near Vision Acuity Test (2nd edn) [7]. As well as the smallest print that could be accurately read, participants were asked to indicate the size they would find most comfortable for a newspaper or magazine. A set of five cards was given, each requiring addition on a small calculator with a green LED display. Two cards required the addition of six single digits; two involved six double-digit numbers; one involved four three-digit numbers. The cards were always presented in the same order. Nobody invited to participate was excluded on grounds of visual impairment or poor motor control. Participants did not need prior experience with computers, but people who were unwilling to use the aid, either because of their attitude to computers or perception of their own memory abilities, were excluded. Previous or present use of any other electronic memory aid did not exclude participants.

Training

During the visit in week 2, participants were encouraged to find and read information in the diary and notebook, and to change some of that information. As figures 1 and 2 illustrate, the interface had been designed and pilot tested so that on-screen choices left no uncertainty about which button to tap. Participants were also asked to make their own new entries in both the diary and the notebook. They were helped to put in the information they personally wanted and were given a manual, comprised mainly of annotated pictures of the various screens, which was left with them for the next 8 weeks. In week 3, they were visited and asked to demonstrate how to find, change and enter details in both the diary and notebook, as well as setting alarms and using the link between diary and notebook. Any forgetting or idiosyncratic procedures that had evolved during the previous week were remedied. Participants had two telephone numbers for contacting members of the project team if they had any queries or if the computer went wrong.
Results

All participants could use all the functionality available when asked to do so. The design solution relied on people’s problem-solving skills when faced with a set of unambiguous choices on the screen, rather than expecting them to remember procedures. Nevertheless, it was found desirable to colour the pen tips for a few participants, to increase the contrast with the screen so that they could more easily see where they were tapping. In addition, the notebook interface was modified for one participant to prevent conceptual errors in daily use, namely entering appointments into the notebook instead of into the diary—an error triggered by prior use of a paper notebook as a memory aid. The modification consisted of preventing any changes to the notebook, but the participant’s partner was shown how to unlock it to add new information. This solution was found acceptable to both participant and carer. So, these data confirm that the project’s main objective was achieved. An interface to memory aids on pocket computers can be designed that can be easily used by people who have sustained brain injury. It needed almost no customizing to meet the needs of these participants.

To address the issue of which style of pocket computer was most helpful for participants, the findings will be presented separately for the qualitative data (questionnaires and interviews), and the performance data (computer logs of actual use). Then, these will be related to the psychometric profiles. All statistical tests reported below are two-tailed unless otherwise specified, but probability values just outside 0.05 are reported because in applied work such as this it may be more serious to wrongly reject an intervention that could be beneficial than to accept the possibility of a benefit that may not exist.

Qualitative data

The marks out of 10 given for features relating to ease of use of the diary and notebook are summarized in table 1, which shows that the diary was considered more useful than the notebook (pooling across computers, the mean rating for the diary was 7.6 compared with 4.8 for the notebook, with 10 people showing a difference in this direction and only two people the reverse (Sign test, \( p < 0.05 \)). The observation that diary ratings were higher for ease of use than for usefulness, indicates that if people did not use the memory aids very much, this was not because they found them difficult to use.

Evaluations of different diary features varied. For example, the alarms were felt to be more useful (8.0) than the repeats (6.6). A difference in this direction was shown by nine of the 10 people who reported a difference (Sign test, \( p < 0.02 \)). These mean figures mask considerable differences between individuals. On most assessments, the Casio received higher ratings than the HP. Pooling across all ratings, nine participants gave higher ratings to the Casio, only two people gave the HP higher ratings (Sign test, \( p < 0.07 \)). Nevertheless, several people commented on the contrasting advantages of each computer: the lightness and portability of the Casio, together with the value of having the alarm ring again if it was not responded to first time, versus the louder alarm of the HP, its larger screen and convenient keyboard. Attitudes to the computer having rechargeable batteries (HP) or not (Casio) varied.

A Casio advantage was also reflected in people’s explicit preferences when they were asked at the end of their participation in the project which computer they
would prefer to keep. Seven people wanted the Casio, only three would keep the HP, and two people had mixed preferences. Although not statistically significant, these preferences are consistent with the pattern of data from the attitude ratings shown in Table 1, suggesting that the Casio was preferred to the HP.

One indication of the usefulness of the pocket computer memory aids to some participants was that eight people said they might purchase a commercial pocket computer in the future. These people accepted the offer of a list of currently available machines, although it was pointed out that the diary and notebook they had been using had been specially developed and were not available on commercial machines. Project team members provided further assistance to any participants who went ahead and purchased commercial machines, and that experience underscored the desirability of having a purpose-designed interface. Prior to joining the project, some participants had given up trying to master a commercial organizer.

During the gap between machines, participants were asked for 1 week to keep a note of events that they would have entered into the electronic diary and to say whether or not these had been successfully remembered. Only seven people made entries in this record (mean number of entries was 11, range 7–24), and only three people recorded forgetting things they would have entered into the diary. A harsh interpretation of these data would be that only 25% of participants benefited from the electronic memory aids. An alternative possibility is that these records are unreliable. Certainly, there was evidence from the handwriting that some records were completed at a single sitting (e.g., just before the delivery of the new computer) rather than throughout the week. Moreover, it is plausible that some activities that were forgotten did not get recorded because they were still not remembered at the time of completing the record, but they might have been prospectively entered into the diary.

**Use of the memory aids**

During the visit in week 3 and the telephone interviews in week 6, all participants could demonstrate the ability to use the electronic diary and the computer

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**Table 1. Attitude towards ease of use as reflected in points out of 10 given immediately after using each computer for 8 weeks (higher = better)**

<table>
<thead>
<tr>
<th></th>
<th>HP</th>
<th>Casio</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diary</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ease of text entry</td>
<td>8.3</td>
<td>8.5</td>
<td>8.4</td>
</tr>
<tr>
<td>Overall ease of use</td>
<td>8.2</td>
<td>8.5</td>
<td>8.4</td>
</tr>
<tr>
<td>Usefulness of alarms</td>
<td>8.2</td>
<td>7.8</td>
<td>8.0</td>
</tr>
<tr>
<td>Necessity of repeats</td>
<td>6.4</td>
<td>6.5</td>
<td>6.6</td>
</tr>
<tr>
<td>Personal usefulness of machine</td>
<td>5.7</td>
<td>7.3</td>
<td>6.5</td>
</tr>
<tr>
<td>Mean</td>
<td>7.4</td>
<td>7.7</td>
<td>7.6</td>
</tr>
<tr>
<td><strong>Notebook</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ease of labelling notes</td>
<td>5.6</td>
<td>7.1</td>
<td>6.4</td>
</tr>
<tr>
<td>Ease of linking to notes</td>
<td>4.3</td>
<td>5.3</td>
<td>4.8</td>
</tr>
<tr>
<td>How often notes used</td>
<td>4.7</td>
<td>5.2</td>
<td>4.9</td>
</tr>
<tr>
<td>Usefulness of short list</td>
<td>2.7</td>
<td>3.5</td>
<td>3.1</td>
</tr>
<tr>
<td>Mean</td>
<td>4.3</td>
<td>5.3</td>
<td>4.8</td>
</tr>
</tbody>
</table>
Frequency of use
The computer unobtrusively provided a detailed record of entries made in the diary and notebook. However, this understates usage because participants may also have read entries on the diary page, e.g. to check times of activities later in the day, or in the notebook several times during the day. Participants varied widely in the use they made of the memory aids. To facilitate comparison between the two computers, the diary data were pro-rated to a duration of exactly 8 weeks, even though some people had the machine for a few days longer (e.g. because of holidays or the need to change appointments). In addition, entries relating to recharging the HP over-night were excluded from the analysis because they would inflate the figures for this machine relative to the non-rechargeable Casio.

The diary enabled people to enter repeated events by tapping a ‘Daily’ or ‘Weekly’ button. Use of the diary can, therefore, be expressed in two ways. Total entries includes repeats and corresponds to the number of diary entries that would be read by a participant. In contrast, new entries excludes repeats after their first occurrence, and corresponds to the number of different entries written by participants. To illustrate how these measures may diverge, compare a person who made one entry but repeated it daily for a week (7 total entries, 1 new entry) with a person who made four entries relating to different activities during that week (4 total entries, 4 new entries). The first person read more, but the second person wrote more. An indication of the independence of these two measures is given by the non-significant correlations between numbers of total and new entries for each machine (Casio $r = 0.24$, HP $r = 0.37$). Where appropriate, both figures are given in the data summaries below. When these two measures converge on the same interpretation, for example in comparing the two pocket computers, this indicates there is no ‘distortion’ due to repetition effects.

The data summarized in table 2 for an 8 week period suggests that participants made approximately three total entries per day, with one new entry per day. On average, both more diary entries and more notebook entries were made with the Casio than the HP, but there was wide variation in frequency of use with both machines. This variation seemed attributable to the participants rather than the

| Table 2. Entries made in pocket computer diary and notebook during an 8 week period |
|---------------------------------|----------|----------|----------|----------|----------|
|                                | Diary    |          | Notebook |
|                                |          |          | Casio    | HP       | Casio    | HP       |
| Total entries                  |          |          |          |          |          |          |
| Casio                          | 155      | 146      | 12.3     | 10.2     |
| HP                             | 73.7     | 134      | 11.9     | 8.1      |
| New entries                    |          |          |          |          |          |          |
| Casio                          | 55       | 53       | 14-3     | 0-27     |
| HP                             | 36.2     | 23.2     | 6        |          |
| Note pages                     |          |          |          |          |          |          |
| Casio                          | 10-429   | 8-139    | 6        |          |
| HP                             | 7        | 8        |          |          |

$n$ using Casio more than HP 7
pocket computers, since people who were high users of one machine tended to be high users of the other. The correlation between the two pocket computers was significant both for total entries ($r = 0.82$, $p < 0.01$) and new entries ($r = 0.71$, $p < 0.01$). So, for some analyses it will be adequate to pool across the computers.

Relation between computer and frequency of use
In order to establish whether the relative use of each pocket computer was similar for high and low frequency users, the data were pooled across machines and participants divided into two subgroups. People in the high use subgroup made more than 300 total entries ($n = 5$, mean 496), and tended to make more total entries with the HP (282) than the Casio (211) (Student’s $t = 2.48$, df $= 4$, $p < 0.07$). In contrast, low users made less than 200 total entries ($n = 7$, mean 174), but made twice as many entries with the Casio (119) as with the HP (56) (Student’s $t = 4.97$, df $= 6$, $p < 0.01$). This suggests that low frequency users were put off using the pocket computer when it had a physical keyboard, whereas those entering more text found the keyboard useful.

This pattern of the difference between the computers varying with frequency of usage could be seen in the analysis of new entries, although it was not statistically significant. Participants were divided into those who made more than 100 new entries when pooling across machines ($n = 6$, mean 168) and those who made less than 100 ($n = 6$, mean 58). For people in the high frequency subgroup, there was little difference in the use of each computer (HP 85, Casio 83), with three people making more new entries with the HP and three making more with the Casio. Amongst the low frequency users, there was a tendency shown by five of the six people for the Casio to be used more than the HP (HP 21, Casio 27, Student’s $t = 0.86$, df $= 5$, n.s.). These data are consistent with the suggestion that the physical keyboard of the HP may have been found off-putting by low frequency users.

Table 3 summarizes the use made of additional functions for both the electronic diary and computer notebook. The only statistically reliable difference between the pocket computers was the proportionally greater use of alarms for diary entries when using the HP (Student’s $t = 2.38$, df $= 11$, $p < 0.04$). This suggests that, although overall the HP had fewer diary entries, these entries were critically time related. This may serve as a caution against too simplistic an interpretation of the quantitative data. A memory aid that performs a safety-net role of alerting the user to critical events can be found very valuable even if that role is not required often.

<table>
<thead>
<tr>
<th></th>
<th>Diary entries</th>
<th></th>
<th>Notebook entries</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Alarm % Tot</td>
<td>Links % New</td>
<td>Repeat % Tot</td>
<td>More text % New</td>
</tr>
<tr>
<td></td>
<td>% New</td>
<td>% Tot</td>
<td>% Tot</td>
<td>% New</td>
</tr>
<tr>
<td>Casio</td>
<td>68.9</td>
<td>7.5</td>
<td>60.9</td>
<td>14.1</td>
</tr>
<tr>
<td>HP</td>
<td>82.6</td>
<td>6.7</td>
<td>50.9</td>
<td>13.5</td>
</tr>
<tr>
<td>Mean</td>
<td>74.7</td>
<td>7.1</td>
<td>55.9</td>
<td>13.8</td>
</tr>
</tbody>
</table>

Table 3. Mean percentage of diary and notebook entries having additional functions
Psychometric profiles

The variability in the frequency of using the memory aids provides an opportunity to consider whether any of the psychometric measures correlated with frequency of diary usage. The memory diaries were not always fully completed during week 1, but eight people completed the diary for at least 5 days. The mean number of memory problems reported per person was 52.8 (range 3–152). Ten participants reported memory problems in five or more different contexts (range 2–20). However, there was no relation between total number of memory problems reported and the number of entries made in the pocket computers ($r = 0.32$). It was noticed that people who withdrew from the study had reported fewer memory problems during the first week than the average participant. (For people who withdrew, the mean number of all problems $= 12.8$; mean number of different problems $= 5.5$.) If this indicated satisfaction with their current memory performance it would explain why they felt less need for memory aids.

The tests of visual acuity and simple arithmetic using a calculator had been intended as a means of filtering volunteers who might have problems using the pocket computers. However, correlations with the number of diary entries made on both computers showed that time taken to complete the additions correlated with total entries ($r = 0.69, p < 0.02$) but not the number of new entries ($r = 0.01$). This indicates that people who were slower at using the calculator, perhaps because of working memory problems rather than manual dexterity problems, tended to have more total entries in their diaries. There was no similar relation between the use of computer diaries and visual comfort level—this measure was chosen because it yielded a wider range than visual acuity (total entries $r = 0.24$, new entries $r = 0.01$).

Sometimes, participants had already done one or more of the tests from the battery used here, and so their scores were now a little higher than they had been on previous occasions. That is to say the measures reported here may be over-estimates of ability in a few instances. A summary of the distribution of participants across the various tests is given in table 4. There were no significant correlations between any single psychometric measure and either the number of total entries or new entries made.

<table>
<thead>
<tr>
<th>NART$^a$ FSIQ</th>
<th>RBMT$^b$ STDP</th>
<th>SCOLP SW$^c$</th>
<th>SCOLP SC$^d$</th>
<th>BADS$^e$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average or above</td>
<td>8</td>
<td>2</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Slightly impaired</td>
<td>3</td>
<td>6</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Severely impaired</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

Correlation with combined diary entries on both machines

*(Need $r > 0.57$ for significance at $p < 0.05$ two-tailed)*

| Total diary entries | 0.50 | 0.52 | 0.19 | 0.06 | -0.45 |
| New diary entries | 0.05 | 0.28 | 0.44 | 0.33 | 0.26 |

$^a$ National Adult Reading Test [8] indicates intelligence prior to the injury.

$^b$ Rivermead Behavioural Memory Test [10] indicates level of memory impairment.

$^c$ Spot the Word test from the Speed & Capacity of Language Processing Test [9].

$^d$ Speed of Comprehension test from the Speed & Capacity of Language Processing Test [9].

Because of the border-line correlation with FSIQ, which estimates pre-morbid intelligence, the use of each machine was explored further by grouping participants into one of three bands (Hi = 121–111, Med = 110–97, Lo = 96–87). Table 5 shows that the total number of entries decreased across these three FSIQ bands, and the biggest difference between the two computers was for those people with the lowest FSIQ scores where the HP was used very little. Caution is needed in interpreting these data since there were only three people in this FSIQ band, but if this is a reliable effect it should replicate in the ongoing study using a similar interface to access a greater range of memory aids on pocket computers.

Another possible critical factor influencing the amount of use made of the pocket computers could be participants’ prior use of reminding systems. On the basis of interview data, participants were classified into two groups; those who were systematic users of memory aids (e.g. diary, calendar, filofax or notebook) prior to joining the project, and those who were not. People were encouraged not to abandon their other aids, since the pocket computers would only be available for the project duration. It might have been expected that people accustomed to using other aids might make less use of the pocket computers, but table 6 shows that this was not the case. People accustomed to using memory aids, of whatever type, tended to make more use of the pocket computers, although the differences between these subgroups of prior organizers were not statistically reliable on a two-tailed test (total entries Student’s \( t = 2.04, df = 10, p < 0.07 \); new entries Student’s \( t = 1.73, df = 10, p < 0.06, \) one-tailed). Sometimes participants used the old and the new aids in conjunction with each other—e.g. setting an alarmed, repeated reminder on the computer to check in their paper diary.

Hardware problems

Two HPs failed and were replaced by the manufacturer. One Casio screen developed a small permanent black patch which might have come from a knock. The diary interface was designed to prevent easy access to the software already installed.
by the manufacturer on the computers. Nevertheless, games were found and played by some participants, and these occasionally caused problems, requiring resetting the machine, which was less straightforward on the HP. The Casio batteries were not rechargeable and for some participants, especially those who often used the backlight to enhance legibility, had to be replaced frequently (e.g. weekly). This problem was exacerbated by the manufacturer’s warning message about low battery status which tended to come on earlier than necessary. There were occasional problems with the Casio calibration (the relation between where the user tapped and where the screen thought it had been tapped). However, there was no obvious relation between a participant’s experience of hardware problems and their willingness to use the aid.

**Discussion**

The main project objective of designing a memory aid that could be used by people after brain injury was achieved. Participants could enter and retrieve information from the memory aids when asked to do so and very little customizing of the interface was needed to accommodate individual needs. With a brighter, colour screen even the colouring of the pen tips may not have been needed. This success was achieved by creating an interface to which people could apply their problem-solving skills to select amongst the choices displayed, rather than having to remember specific details of how to make entries in the diary or set alarms. This is not to suggest that the interface was perfect for everyone. The debriefing interviews elicited a variety of requests, usually for additional functionality, some of which are being followed up in this ongoing project.

In case it was needed, the research team had created an even more supportive interface, where only one element of making a diary entry was possible on each screen, and the actions needed for doing this were explicitly prompted on the screen. But, no participants needed this additional guidance. The attitude ratings confirmed that people found it very easy to use the diary on both computers. However, the variation in the frequency with which the aids were used suggested that there were a number of other critical factors determining how much the diary would be used.

One potentially important factor could be the patients’ insight into their need for memory assistance. People may not bother to enter reminders for events they think they will remember. Another possibility is that a more general lack of motivation underlies the reluctance to use the aid. This possibility is being addressed within this ongoing project by introducing other activities for which the pocket computer can be used (e.g. games). If people are encouraged to use the computers more often, they might find themselves more willing to enter reminders in the diary while they have the pocket computer in their hands and switched on. A third possibility, and one supported by the data in table 6, is that use of the memory aids relates to time management and scheduling skills. People who tend to plan their day ahead in some detail may be those who use the memory aids often. This suggestion is consistent with reports that people who used a variety of remembering strategies prior to their injury were likely to use more after the injury than people who premorbidly used few external reminding strategies [11]. Others have reported finding a similar relation [13], and this may point to the value of training
people in how to use diaries and memory aids during rehabilitation from brain injury.

This relation between use of the pocket computers and prior use of memory aids might reflect the role of familiarity-plus-perseveration, with people preferring to continue managing their daily routines after the accident by whatever methods they had been using before. However, there was some evidence for a knowledge or skills deficit contributing to low use of the aids. Amongst the participants in the project, not everyone seemed to understand how to use reminding devices to their best advantage. For example, one participant had a fixed shopping list that was looked at only in the shop, where decisions were made about whether specific items were needed this week. If remembering things is a problem, then this strategy may not be as safe as checking the items before leaving home. It is known that interface factors may excuse people about the cognitive demands of available options [15], but that seems unlikely to have been a factor in the present study. An appropriately designed interface can ensure procedural adequacy, but it is not so easy to help participants set relevant goals for using memory aids.

The present study has provided data on the relative suitability of two pocket computers, one with and one without a keyboard. These data strongly suggest that different pocket computers suit different participants. People who used the memory aids often, made greater use of the pocket computer with a keyboard (the HP). In contrast, people who made few entries in the diary made greater use of the smaller palm-size computer without a keyboard (the Casio). While it might be expected that people who make more entries will value more highly the physical keyboard as a convenient means of entering text, the strong antipathy for the HP among those who made relatively little use of the diary and other memory aids is less easily accounted for. The compromise of a palm-size machine with a detachable keyboard might satisfy both high and low frequency users.

The benefits of a simplified interface for a pocket computer memory aid are likely to extend beyond brain injured patients, for example to older people, many of whom experience age-related memory loss [14]. Indeed, there is evidence that older people have greater difficulty with remembering timed rather than untimed events [16], and so should benefit from the auditory alarm coupled with a visual reminder of the activity that the pocket computer provides.

Conclusions

This study has established that people with memory impairments resulting from brain injury can use purpose-designed computer-based memory aids, comprising an appointment diary, notebook and links between them. Several participants found these aids of great benefit. The design solution is to present people with an unambiguous set of choices and then rely on their problem-solving skills rather than expecting them to remember procedures. The amount of use made of the pocket computers varied widely between individuals, and appeared related to people’s use of other memory aids. Frequent users preferred the computer with a keyboard, whereas infrequent users preferred the smaller, palm-size device. A compromise such as a palm-size computer with a detachable keyboard might meet the needs of both groups.
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