The ultimate goal of rehabilitation is to enable people to function as independently as possible in their own most appropriate environment (McLellan, 1991). In the early days or weeks after brain injury, most people, including therapists and psychologists, are looking for recovery and some restoration of lost functioning. Once recovery has stopped or slowed down, we tend to adjust our expectations and help people compensate for their difficulties. Anderson (1996) suggested that attempts to restore lost functioning stem from a belief in a major degree of neural plasticity, whereas compensatory strategies are based on the assumption that we cannot restore lost functioning so we need to teach people how to cope better with their difficulties. Robertson and Murre (1999) put forward somewhat similar views, arguing that compensatory strategies should be the treatment of choice for people who are not expected to recover, whereas for those who are expected to recover (e.g., those with milder lesions) trying to enhance the rate of recovery may be more effective. This may be true for some cognitive functions such as language and attention, but it would not appear to be true for memory, where there is little evidence of major improvements in function once the initial period of spontaneous recovery has passed (Kapur & Graham, 2002; Wilson, 2004). Indeed, Robertson himself noted that “in the case of memory rehabilitation, there is yet no evidence for direct

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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).

We have already discussed recovery of function in Chapter 2. This present chapter, as already stated, focuses on compensatory aids. Zangwill (1947) defined compensation as “reorganization of psychological function in order to minimize or circumvent a particular disability” (p. 63). He argued that compensation for the most part took place spontaneously, without explicit intention by the patient, although in some cases it could occur by the patient’s own efforts or as a result of instruction and guidance from the psychologist/therapist. The examples of compensation offered by Zangwill include giving a person with expressive speech impairment a slate to write on or teaching someone with a right hemiplegia to write with his or her left hand.

Although external memory aids are arguably the most efficient strategies for memory-impaired people, it is not always easy for them to use such aids. Efficient use of many external memory aids involves a degree of motivation, patience, planning, problem solving, concentration, learning, and, indeed, memory, so the people who need them most often have the greatest difficulty in learning how to use them. This chapter describes the most commonly used external aids and their use. Examples of the successful use of aids in people with severe memory deficits are provided, and the setting up of a memory aids clinic is discussed.

The provision of memory aids needs to be seen in the context of other attempts to improve memory functioning in patients with brain dysfunction. The teaching of cognitive strategies, such as association and rehearsal techniques, is covered in Chapters 5 and 6. Changes in behavior may also benefit memory, such as reducing the workload, establishing regular routines, and always putting items back in the correct place. More general advice relating, for example, to fatigue, anxiety, and alcohol and drug use may benefit memory functioning indirectly. External memory aids represent a somewhat distinctive form of intervention in that greater reliance is placed on an external object or part of the environment rather than purely cognitive or behavioral strategies initiated by the memory-impaired individual. The primary focus of this chapter is on portable or installable memory aids. The design of buildings or equipment may function as a form of memory aid, and these “environmental memory aids” are discussed in more detail elsewhere (Wilson & Kapur, 2008) and in Chapter 11, but we include here Table 4.1 to illustrate how environmental management strategies may help confused and agitated patients in the acute stage.

This chapter focuses more closely on practical aspects of the application of external memory aids in memory rehabilitation settings. The
reader is referred to recent articles for more detailed consideration of experimental studies of external memory aids (Kapur, Glisky, & Wilson, 2002, 2004; Sohlberg, 2005; Sohlberg et al., 2007) and to books by Kime (2006) and Bourgeois (2007) for practical approaches to implementing compensatory strategies using external memory aids. Although we are more concerned with people with nonprogressive conditions, we direct readers to a recent special issue of the journal *Technology and Disability*, “Technology in Dementia Care” (Hagen, 2007), which includes such topics as cost–benefit analysis of assistive technology and the use of technology to improve QOL for people with dementia.

### Typology of Memory Aids

Compared to conceptual frameworks for memory systems in general, and to specific systems such as working memory, autobiographical memory, and semantic memory in particular, there have been relatively few,
if any, attempts to offer a typology of memory aids. This is regrettable because having at least a rudimentary model of the enhancing effects of memory aids may help to gain a better understanding of the ways in which memory aids are effective and how their effectiveness can be improved. It is unlikely that simply mapping external memory aids onto existing conceptual frameworks for memory systems would be helpful: For example, thinking in terms of episodic memory aids and semantic memory aids does not seem to make intuitive or practical sense.

As a first approximation, it appears that external memory aids can be divided into those that act as alerting cues, offering a cue at a particular time and in a particular place, and those that take the form of representational aids, in that they provide a stored representation of information that is not tied for its value to a particular temporal or spatial context. Alarms that help prospective memory would seem to fit neatly into the former category, while notepads and Dictaphones are ready examples of devices that store information for later use. The most widely used form of representational memory aid is the written language and electronic variants of writing. Paintings, photographs, sculptures, and gravestones can also be seen as representational memory aids. However, some devices may be multimodal, blurring this simple distinction. For example, satellite navigation devices store representations of the outside world but also provide alerting cues at certain points in space.

**Which Are the Most Frequently Used Memory Aids?**

Most people without neurological memory deficits use memory aids (Harris, 1980; Long, Cameron, Harju, Lutz, & Means, 1999; West, 1995); lists, notes, and calendars are used most often. Park, Smith, and Cavanaugh (1990) found that psychologists involved in memory research typically wrote things down to help them remember. What about people with neurological memory impairment? Evans, Wilson, Needham, and Brentnall (2003) surveyed 94 memory-impaired survivors of brain injury to identify the most commonly used memory aids. As can be seen in Table 4.2, nonelectronic aids are the overwhelming choice of tool for people with memory problems: Of 44 different aids used, 35 (79.5%) were nonelectronic. The most widely used electronic aids were an alarm clock for wake-up purposes (used by 38 [40.4%] patients), followed by a watch with the date or timer (used by 17 [18.1%] patients). The top four memory tools were (1) a wall calendar or wall chart \(n = 68\ [72.3\%]\); (2) a notebook \(n = 60\ [63.8\%]\); (3) a list \(n = 59\ [62.8\%]\); and (4) an appointment diary \(n = 51\ [54.3\%]\).
<table>
<thead>
<tr>
<th>Strategy</th>
<th>Number (percentage) of sample using the strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Wall calendar/wall chart</td>
<td>68 (72.3)</td>
</tr>
<tr>
<td>2. Notebook</td>
<td>60 (63.8)</td>
</tr>
<tr>
<td>3. List</td>
<td>59 (62.8)</td>
</tr>
<tr>
<td>4. Appointment diary</td>
<td>51 (54.3)</td>
</tr>
<tr>
<td>5. Asking others to remind</td>
<td>46 (48.9)</td>
</tr>
<tr>
<td>6. Mental retracing</td>
<td>45 (47.9)</td>
</tr>
<tr>
<td>7. Alarm clock (for wake-up)</td>
<td>38 (40.4)</td>
</tr>
<tr>
<td>8. Objects in unusual place</td>
<td>33 (35.1)</td>
</tr>
<tr>
<td>9. Notes in special places</td>
<td>32 (34.0)</td>
</tr>
<tr>
<td>10. Repetitive practice</td>
<td>28 (29.8)</td>
</tr>
<tr>
<td>11. Writing on hand</td>
<td>23 (24.3)</td>
</tr>
<tr>
<td>12. Making associations</td>
<td>20 (21.3)</td>
</tr>
<tr>
<td>13. Watch with date/timer</td>
<td>17 (18.1)</td>
</tr>
<tr>
<td>14. Daily routine</td>
<td>17 (18.1)</td>
</tr>
<tr>
<td>15. Personal organizer</td>
<td>16 (17.0)</td>
</tr>
<tr>
<td>16. Journal</td>
<td>15 (15.9)</td>
</tr>
<tr>
<td>17. Daily timetable</td>
<td>14 (14.9)</td>
</tr>
<tr>
<td>18. Alarm clock/timer</td>
<td>9 (9.6)</td>
</tr>
<tr>
<td>19. Visual imagery</td>
<td>9 (9.6)</td>
</tr>
<tr>
<td>20. Weekly routine</td>
<td>9 (9.6)</td>
</tr>
<tr>
<td>21. Alphabetical searching</td>
<td>7 (7.4)</td>
</tr>
<tr>
<td>22. Electronic organizer</td>
<td>7 (7.4)</td>
</tr>
<tr>
<td>23. TV guide (annotated)</td>
<td>7 (7.4)</td>
</tr>
<tr>
<td>24. Pillbox with day/time</td>
<td>6 (6.4)</td>
</tr>
<tr>
<td>25. First-Letter mnemonics</td>
<td>5 (5.3)</td>
</tr>
<tr>
<td>26. Pager</td>
<td>5 (5.3)</td>
</tr>
<tr>
<td>27. Recipe card or book</td>
<td>5 (5.3)</td>
</tr>
<tr>
<td>28. Pleasantness rating</td>
<td>3 (3.2)</td>
</tr>
<tr>
<td>29. Key chain</td>
<td>3 (3.2)</td>
</tr>
<tr>
<td>30. Pocket phone book</td>
<td>3 (3.2)</td>
</tr>
<tr>
<td>31. Mobile phone</td>
<td>3 (3.2)</td>
</tr>
<tr>
<td>32. Dictaphone/tape recorder</td>
<td>2 (2.1)</td>
</tr>
<tr>
<td>33. Rhymes</td>
<td>2 (2.1)</td>
</tr>
<tr>
<td>34. Knot in handkerchief</td>
<td>2 (2.1)</td>
</tr>
<tr>
<td>35. Orientation of medication</td>
<td>2 (2.1)</td>
</tr>
<tr>
<td>36. Dictionary</td>
<td>2 (2.1)</td>
</tr>
<tr>
<td>37. Chunking</td>
<td>1 (1.1)</td>
</tr>
<tr>
<td>38. Information on key ring</td>
<td>1 (1.1)</td>
</tr>
<tr>
<td>39. Home filing system</td>
<td>1 (1.1)</td>
</tr>
<tr>
<td>40. Home accounts</td>
<td>1 (1.1)</td>
</tr>
<tr>
<td>41. Instructions for work on wall</td>
<td>1 (1.1)</td>
</tr>
<tr>
<td>42. Organizer handbag</td>
<td>1 (1.1)</td>
</tr>
<tr>
<td>43. Buying small quantities</td>
<td>1 (1.1)</td>
</tr>
<tr>
<td>44. Clock calendar combination</td>
<td>1 (1.1)</td>
</tr>
</tbody>
</table>

These findings are reasonably similar to an earlier study of 43 memory-impaired people who had received rehabilitation for memory problems 5 to 10 years previously (Wilson, 1991). Of the 43 participants, 29 (67.4%) used notes or notebooks and 25 (58.1%) used wall charts or wall calendars. In both studies, some participants had devised their own rather idiosyncratic memory device. For example, in the 1991 study, one man used a special watch to remind him of a drop in body temperature, because he had hypothalamic damage that could have caused him to suffer from hypothermia. Another woman tore the tops from packets of items she needed to replace and put the tops on the kitchen table to remind her to take them with her when she went shopping. In the 2003 study, one man put instructions for work on the wall to remind him what had to be done, and another person only ever bought small quantities of food in case she forgot to use up all her stock. Thus, it can be seen that nonelectronic aids are widely used and very variable.

Most people used more aids at follow-up than they had used before the onset of the brain injury. In Wilson (1991), a mean of four aids were used before injury compared with 7.39 postinjury. Likewise, Evans et al. (2003) found a mean of 2.45 aids were used preinjury versus 6.8 postinjury. In both studies, there is a relationship between the use of aids and independence, suggesting that being independent in the context of a memory impairment requires the use of memory aids. Two provisos may be worth keeping in mind: (1) The estimates of preinjury/illness memory aids were retrospective and may have underestimated or otherwise distorted estimates because of the length of time since use of the aids; and (2) those individuals who were more independent may have had higher levels of general cognitive functioning or educational attainment, and this may also have contributed to their frequent use of memory aids.

How Effective Are External Memory Aids?

In the case of everyday adjustment, both studies described previously (Wilson, 1991; Evans et al., 2003) directly or indirectly assessed the efficacy of memory aids. Wilson (1991) found that people living independently (defined as living alone, in paid employment, or in full-time education) were more likely to be using six or more aids and strategies than those who were not independent (X² = 10.87, p < .001). Evans et al. (2003) examined more closely the efficiency of the aids/strategies by asking an independent other to rate their use (1 = rarely effective, 2 = sometimes effective, 3 = usually effective). It appears that the most widely used
Aids are not necessarily the most effective at least as rated by caregivers. Although we need to be cautious, some strategies appear to be used by a small number of people but to good effect. These include both electronic and nonelectronic aids. Of the nonelectronic aids, tying a knot in a handkerchief (or the American equivalent of tying a string round a finger) was not effective, whereas following a weekly or daily routine, making lists, and asking others for reminders received high ratings. Remembering to take medication is an important everyday goal of some memory-impaired individuals: Van Hulle and Hux (2006) reported that a wristwatch alarm and a digital voice reminder were effective in improving compliance in three individuals with TBI.

In the case of laboratory- or clinic-based measures, a number of relevant studies have been described elsewhere (Kapur et al., 2004; Sohlberg, 2005). More recent studies have confirmed the value of cuing, even if it is content free, in enhancing prospective memory (Fish et al., 2007). O’Connell et al. (2008) showed that a group of individuals with attention–deficit/hyperactivity disorder could be taught a self-alerting technique, with the benefit of biofeedback, and that this improved performance in a sustained attention task involving remembering to inhibit a response to a particular cue. Fish et al. (2008b) reported that an electronic pager was more effective than a checklist in encouraging a patient with bilateral frontal lobe pathology to implement everyday intentions and suggested that this was achieved by encouraging goal-monitoring behavior. Gentry (2008) assessed the effectiveness of an off-the-shelf personal digital assistant, the Palm Zire 31, and found that a group of patients with multiple sclerosis showed improvements in cognitive independence, mobility, and social integration after being trained to use the device. It is worth noting that formal memory test scores did not show an improvement over the same period. In a similar study with head-injured patients, Gentry, Wallace, Kvarfordt, and Lynch (2008) found similar improvements in the areas of mobility, cognitive independence, and occupation. Several studies have demonstrated the effectiveness of a paging system, NeuroPage, to help survivors of brain injury compensate for everyday memory and planning problems (Wilson, Evans, Emslie, & Malinek, 1997; Wilson, Emslie, Quirk, & Evans, 2001; Emslie et al., 2007; Fish et al., 2008c).

**Can We Predict Who Will Use External Memory Aids Efficiently?**

We know that some memory-impaired people use external aids well and easily while others experience great difficulty. What determines whether
Compensating for Memory Deficits with Memory Aids

Wilson and Watson (1996) described a framework for understanding compensatory behavior in people with neurological memory impairment. This framework, developed by Bäckman and Dixon (1992) and further modified by Dixon and Bäckman (1999), distinguishes four stages in the evolution of compensatory behavior: origins, mechanisms, forms, and consequences. Wilson (2000) used this framework to consider compensation for a variety of cognitive deficits. Evans et al. (2003) investigated factors that predict good use of compensatory strategies. The main predictors appear to be:

1. Age—younger people compensate better.
2. Severity of impairment—very severely impaired people compensate less well.
3. Specificity of deficit—those with widespread cognitive deficits appear to compensate less well than those with more focal deficits.
4. Premorbid use of strategies—those who had used some compensatory aids premorbidly appear to compensate better after their brain injury/illness.

This area requires further evaluation. If we can predict who is likely to compensate without too much difficulty, we can target our rehabilitation to help those who are less likely to compensate spontaneously. Clinical experience tends to suggest other variables that are likely to be important, including insight and motivation, support from family members and work colleagues, and absence of major sensory, motor, or psychiatric disability. Stapleton, Adams, and Atterton (2007) noted that of five individuals with TBI who were given mobile phones as a memory aid, the two individuals who did not successfully use the mobile phone to remember to carry out target behaviors had marked memory impairment and some executive dysfunction and required 24-hour care.

**Which Assessment Procedures Are Most Appropriate When Considering Patients for External Memory Aids?**

Various forms of assessment are required to help determine those patients who will benefit most from external memory aids. A formal neuropsychological assessment will provide information on key factors such as the severity of memory impairment and the presence of major executive dysfunction. A clinical assessment will be helpful to gauge previous use of aids, insight, motivation, memory demands in work, and
support that will be available from caregivers/family members and work colleagues. This assessment will also point to major problems in mood, temperament, or anxiety and other factors such as tiredness, alcohol/drug abuse, sleep disturbance, and so on, that could interfere with a rehabilitation program. It may also be useful to gather simple measures of the degree of stress caused by memory difficulties and caregivers’ stress as a result of looking after and living with a memory-impaired person. Basic memory questionnaires completed by the patient and by an informed observer will help to confirm information from an interview as to the main everyday memory difficulties. Structured questionnaires will also help to gather information on existing cognitive-behavioral strategies and the external aids or other techniques that the person is using. A further assessment that we have found useful in clinical practice is a memory problem-solving inventory, in which written scenarios are presented, such as “How would you remember to mail a letter?” and “How would you remember to send a friend a birthday card?” The clinician should have an idea of the range of strategies that could be used to solve these problem situations, and the plan would be to repeat administration of such an inventory after intervention with memory aids. Having gathered information on the key memory lapses that require intervention, one would ideally proceed to gather a record of the frequency and related circumstances of these lapses. This diary itself requires a degree of memory and concentration, and it is here that a caregiver will be invaluable. It may be that providing a patient with a notebook or simple Dictaphone or perhaps a memo pad that can be attached to a fridge door with a magnet will help improve compliance in keeping a record of memory lapses. Periodic telephone calls will also help to ensure that patients and caregivers are being diligent in recording everyday memory lapses.

As Scherer (2005) has pointed out, successful use of external aids in helping to achieve goals for memory-impaired individuals will depend on a good match between a number of variables, including insight and motivation; past use of memory aids; cognitive, emotional, and motivational profile; everyday demands on memory; family/work support; and the various cognitive and behavioral strategies and types of memory aids that are available as part of the resources of the clinician.

**Setting Up a Memory Aids Clinic**

Memory aids clinics would seem a logical consequence of memory rehabilitation efforts, but it was a surprise to one of the authors of this chapter (Narinder Kapur) that there were few, if any, precedents for such a
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clinic when he set one up. The absence of such clinics may have been for several reasons: the relative scarcity of many external memory aids before the 1990s; the difficulty in finding about and purchasing aids, which only became possible in the late 1990s with the growth of the Internet; the absence of ready sources of funding for the purchase of memory aids in many health care settings; and the relative paucity of publications on the role and effectiveness of memory aids.

In 2003, the first memory aids clinic in the United Kingdom, and possibly in the world, was set up at Addenbrooke’s Hospital, Cambridge (Figure 4.1).

It is said that for something to be successful it needs a good idea, good resources to back it, and good people to take the idea forward. Fortunately, these elements were in place when this memory aids clinic was set up. In collaboration with Professor Michael Kopelman and Ms Bonnie-Kate Dewar, we also helped to set up an equivalent memory aids clinic at St. Thomas’s Hospital, London, in 2006.

Funding

Most developments in health care settings require a business plan, but we did not have such a plan when we set up our clinic in Cambridge. Through sources such as private patient income, support from Microsoft Research as a result of a research collaboration, and personal financial input from the head of the clinic (Narinder Kapur), we were able to put together the resources necessary to purchase material items and basic infrastructure. A dedicated testing–treatment room was made available by the hospital and was the site of the memory aids clinic. It was used for routine neuropsychological assessments and housing of test materi-

FIGURE 4.1. Part of the Cambridge Memory Aids Resource Centre. Reprinted with permission from Narinder Kapur.
als and a range of memory aids. The material costs of maintaining a memory aids clinic depend on patient traffic. Currently, we see about 100 patients a year in the clinic, and we give them memory aids free of charge. One would need to allow approximately $10,000 to set up and supply the clinic with a broad range of aids and $100 per patient expenditure on aids. Staffing costs are, of course, extra (see later discussion).

It is possible that a memory aids clinic could be set up initially as a research project, funded by a medical research source, and the results of the study then used to persuade local stakeholders to invest in the clinic. A further means of gathering funds is to persuade a patients' charity, such as those dealing with multiple sclerosis, epilepsy, stroke, AD, TBI, or encephalitis, to fund the clinic for their patients for a 3-year period, with a promise from the health care provider or local health care commissioners to continue that funding after the 3-year period.

**Staffing**

Ideally, a memory aids clinic with 100 patients should have a full-time qualified clinical psychologist, one full-time assistant psychologist, and a part-time secretary.

**Range of Aids and Support Materials**

The clinic and resource center should be in the same location and should house a wide range of memory aids. These include “concept aids,” which are seldom given out to patients but are kept for demonstration purposes to indicate current trends and developments in technology. For example, advanced mobile phones are usually too expensive to give routinely to patients but may be useful to have on display. A second type of memory aid may occasionally be given out but only for select cases: location detection memory aids that help people find items such as lost keys. The third type of external memory aid can be given out frequently: White boards, Post-it Note materials, simple electronic reminders, and Dictaphones. The aids need to be displayed in meaningful groupings, with appropriate signage on the display shelves. If possible, paste a note beneath each memory aid, indicating when and from whom (website, telephone number, e-mail address) it was purchased and the cost.

Memory aids will need dedicated brochures given to patients for back-up explanations and use instructions. These should be available as part of the display materials. In addition, providing external memory aids will usually be only one part of an overall holistic rehabilitation program; other support literature (e.g., dealing with concentration difficulties; coping with stress, anxiety, and depression; anger management;
returning to work after a brain injury/illness) should be available for patients and caregivers.

The memory aids resource center will be your “showcase” for visitors, some of whom will be financially responsible for purchases, so it is important that it looks as impressive as possible. The resource center should also house a range of spare batteries and simple materials such as screwdrivers and double-sided tape for making impromptu memory aids.

**Audit**

Audit should be built in to the running of the memory aids clinic to show that it is both efficient and cost-effective. Value is often defined as output divided by cost, and anyone running a memory aids clinic needs to be able to demonstrate value, especially if starting with seed funding and seeking more substantive funding at a later stage. Audit instruments will include not only standard assessment procedures such as reduction in memory lapses but also other measures such as work, domestic or leisure goals, reduction of stress for the patient and caregiver, and improved self-esteem. Gathering long-term follow-up data on the continued use of aids after 1 to 2 years is also important. The costs of care, savings in health care measured in outcomes such as better medication compliance, and income generated by the individual returning to work all need to be computed so as to provide some idea as to whether the clinic has been cost-effective (cf. Turner-Stokes, Disler, Nair, & Wades, 2005).

**Finding and Purchasing Memory Aids**

The Internet is invaluable not only for tracing the wide range of memory aids that are now available but also for the ease of purchasing and shipping these aids. It may be necessary to pay with your own credit card and also try to put in place some means of reimbursement for the purchases you have made.

**Cataloging of Aids**

Although ideally one would keep an inventory of memory aids, the range and cost of available aids will change every few months, so this may not be feasible logistically. It is, however, important to keep a note of past aids purchased, from whom, and so on and also a catalog of aids that are currently available. Categories of memory aids may include Post-it Note materials; notebooks, diaries, or filofaxes, or personal organizers; elec-
tronic reminders; pillboxes; White boards; location detectors; mobile phones; audio recording devices; photographic devices; and navigation devices.

**Advertising for Business**

Generally, once it is known that a memory aids clinic is in operation, there should be no shortage of referrals. However, if necessary, communication with local patient organizations may be helpful. It is important to give some general idea as to exclusion criteria to restrict the number of unsuitable referrals. Promotion on local radio and TV shows or in newspapers may also help to increase publicity for the memory aids clinic.

**Research and Development**

It is important to have some form of research activity as part of the running of the memory aids clinic. In Cambridge, we were fortunate that Microsoft Research had a major research laboratory based in the city and were developing a prototype camera-based memory aid that was intended to improve autobiographical memory. This research collaboration helped to fund the resources in the memory aids clinic and also provided staff who were able to spend a day a week in the clinic or related clinics.

**Compliance and Generalization**

Showing a patient one or two memory aids in the clinic and supplying them for use at home or at work is fine, but how can one ensure compliance? This question needs to be kept to the fore. Ideally, if staffing resources permit, one or two home or work site visits as well as regular phone calls, should be made. The use of virtual reality procedures, perhaps with embedded images of the patient’s home or workplace, may also be worth considering as part of the goal of transitioning the use of aids from the clinic to the community.

**Which Types of Memory Aids Are Currently Available?**

**Information Display Items**

We live in a visual world, with much of the human brain devoted to visual processing, so visual display items that provide memory-related
Compensating for Memory Deficits with Memory Aids

Information are useful memory aids. They need to be in the field of view of the user and not subject to the vagaries of gaze. Types of display items that are often used as memory aids include day/date clocks, White boards, and labels on cupboards. A refrigerator door with messages or reminders could also be classified as a form of information display memory aid. Calendars with space for messages or lists of things to do also fall into the category of information display materials. Some digital frames can display time/day/date together with preprogrammed items, and these may also be worth considering.

**Electronic Reminders**

A wide range of electronic reminder alarms are available. They include electronic timers, multi-alarm reminders (with ±30 alarms that can be set at half-hour settings), mobile phones with alarm features, pagers, watches with a range of alarm features, and pillboxes with built-in multiple electronic alarm settings. Electronic reminders may be part of the design of a building, as in the case of “smart homes” (Boman, 2007).

**Location Detection Devices**

Location detection devices have been designed to help individuals remember where they put things. In a newer variation of this, an alarm will sound if something is left behind. Usually, an item is tagged with an electronic receiver, and when the emitting device sends a radio signal the tagged item will emit a loud sound. Some devices have a visual display panel indicating the proximity of the item that is lost.

**Way-Finding Aids**

Satellite navigation devices have been a major development in external aid support for those who have difficulty finding their way to a destination. Such devices now come in various forms: as built-in components of automobiles, as stand-alone devices that can be located near the dashboard of a vehicle, and as devices that can be integral features of personal digital assistants or mobile phones and can be used while the person is walking about. These devices invariably have spoken commands in addition to dynamic visual cues. Static road maps and suggested routes can also now be downloaded to mobile phones, laptop computers, and so on, and screen or print versions of these may also be useful as navigational memory aids. It is also worth noting that for those patients with marked memory impairment or confusion resulting from other cognitive deficits, navigating within a residence may be
problematic. In these instances, navigational aids may take the form of supportive architectural design, strategically located landmarks, icon and text-based signs, and so on (Warner, 2000; Zeisel, 2006).

**Electronic Storage Devices**

Devices such as personal digital assistants, mobile phones, landline phones, cameras, and computers may provide a means of information storage, including photographs, contact details, and “journal” records of past autobiographical events. Audio recording may be a feature of mobile phones, but dedicated, easy-to-use Dictaphones with large storage capacity and connectivity with computers have become available in recent years. A photophone (Figure 4.2) has large buttons on which a photograph of a significant person is pasted. When the memory-impaired individual wants to call this person, he or she just presses the button with the photograph and the number is speed-dialed automatically.

**Post-It Note Materials**

Post-it Note materials are among the most widely used external memory aids, by both those with brain injury and the general population. A variety is now available that is useful for indexing pages. Post-it Note tape is available in three widths, the widest of which (2.6 centimeters) is invaluable for labeling, using as a temporary notepad, or using as a cue/sign in a strategic location. Post-it Notes are available in dispensers, and one of these, with a pen next to a telephone, can make it easier for patients to jot down messages that can then be readily transferred to a White board, refrigerator door, and so on.

**Diaries, Filofaxes/Personal Organizers, Stationery Items**

Some individuals, especially elderly people, prefer to use stationery items such as filofaxes/personal organizers and diaries rather than electronic personal digital assistants. For these people, there are many items of varying sizes, with varying preprinted inserts, that may help them keep track of things to do or messages.

**Mechanical and Other Storage Devices**

Pillboxes, one of the most common type of mechanical memory aids, will be a staple item to have stocked in a memory aids resource center.
These vary in size, transparency of material, and number of compartments, depending on the medication regimen. Many pillboxes now come with built-in electronic reminders. Other, often overlooked forms of storage items include clothing with a number of pockets to store memory aids and related material while on the move. Handbags/purses with well-organized compartments are also helpful. The latter may be particularly important for patients with marked memory impairment and will help to avoid distressing episodes at the checkout counter while shopping when cash or credit card items cannot be readily found.

**How Can We Best Teach People to Use External Memory Aids?**

Although the application of many external memory aids looks straightforward, the use of each involves a degree of memory and concentration, so those who need memory aids the most may have the greatest difficulty learning how to use them. Glisky, Schacter, and Tulving (1986)
taught people with amnesia to remember computer-related terminology through the method of VC, which involves the systematic reduction of letters (described in Chapter 6). Glisky (1995) taught an amnesic patient a considerable amount of information about a word-processing task. These two studies are not teaching people to use computers per se but rather are teaching them about the use of computers. One of the first reports of a systematic attempt to teach the use of a nonelectronic organizer was that of Sohlberg and Mateer (1989c). They described a systematic structured training sequence to teach the use of a memory book and provide an example of this training sequence with a memory-impaired patient. The patient’s book comprised five color-coded sections (although the authors pointed out that the number of sections could be decreased or increased as necessary): (1) orientation, (2) memory log, (3) calendar, (4) things to do, and (5) transportation. The training sequence involved three processes: acquisition, application, and adaptation. In the first stage, the patient was taught the use of each section of the book, then taught to apply it to situations encountered at the rehabilitation center, and finally taught to use it in real life.

Although Sohlberg and Mateer believed that patients need to have explicit knowledge of the features of the organizer before using it in real-life situations, Kapur et al. (2004) felt that explicit recall is not always necessary provided that the organizer is used accurately. This view is supported by the experience of “Jay,” described in Wilson (1999), who could use a data bank watch very accurately but had no explicit knowledge of how to enter messages into the watch. Zencius, Wesolowski, Krankowski, and Burke (1991) found that training patients to use a memory book was more effective in improving everyday performance than other methods. For Donaghy and Williams (1998), a modified version of the training suggested by Sohlberg and Mateer improved performance.

Kime, Lamb, and Wilson (1996) provided some details regarding the successful training of a severely amnesic patient in using a datebook (an organizer) so that she was able to return to independent living and eventually to paid employment. The patient, A. B., sustained multiple injuries in an automobile accident at the age of 22. Three months later, she went into status epilepticus and suffered anoxic brain damage, resulting in a very severe amnesia. Almost 2 years after the accident, A. B. was admitted to a rehabilitation center, where she was found to have very severe deficits on neuropsychological tests of memory and in everyday memory. After several days, she could not remember the names of the therapists treating her, the purposes of each session, the location of the bathroom, or indeed the fact that she had participated in the
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rehabilitation program for the past few days. One of the main strategies used to help A. B. was the provision of a datebook/organizer and a watch alarm that chimed every hour to remind her to refer to the organizer. The organizer contained five sections: (1) daily time log, (2) instructions for using the watch (see Figure 10.1), (3) the location of the different therapists, (4) names of the therapists, and (5) maps of the rehabilitation center and of the apartment complex where A. B. lived during her stay at the center. In addition, there was a separate section for each therapy session, including a brief description of the purpose of the session and the name of the therapist running that session. Later, additional sections were incorporated as required, namely letters she had written, people to whom she had talked, films she had seen, and a calendar of future events.

Initially A. B. was resistant to using the watch alarm and was embarrassed at having to carry the organizer. Nevertheless, she was prompted to use this during each therapy session and also at home with her mother’s help. To help her learn how to use the book, different therapists would provide A. B. with messages and assignments. For the first few weeks of the program, A. B. was always accompanied by a therapist or a family member. Whenever the watch sounded, the person with A. B. would ask her to check her book and carry out the appropriate action. Thus, if the alarm sounded at 10:00 A.M. and A. B. did not respond, her chaperone would remind her that the alarm was a signal to check her datebook. When A. B. found the correct entry, the chaperone would ask, “What are you supposed to do now, A. B.? Yes, phone your mother.” Once the correct action was completed, A. B. was asked to initial the action record section, A. B. began taking on responsibility herself. Later in the action record section, A. B. began to write notes to herself to do specific tasks or record specific conversations. After this, she was encouraged to enter cross-references to previous notes or entries to facilitate recall. Finally, A. B. was encouraged to make notes on a monthly planner to promote confirmation and completion of tasks. The main goal of this training was to ensure that A. B. generalized the intervention techniques to home and would be able to live independently. The main outcome measures were: (1) the percentage of occasions A. B. checked her datebook when the alarm chimed; (2) the number of entries in the
action record in her datebook; (3) the number of cross-references in her datebook; and (4) the number of separate entries in her monthly calendar. In fact, A. B. was not allowed to fail at any of the tasks, so the training probably worked through an EL learning procedure, which is described in Chapter 6.

Measures were taken at four different times during the rehabilitation process: the first 21 days after the introduction of the datebook, the last 21 days before discharge from the program, 4 months postdischarge, and 13 months postdischarge. There was a significant improvement in the first and second 21-day measures. Her performance did not decline significantly once she left the rehabilitation center apart from the monthly calendar, which decreased and then increased again. A. B. was able to return to employment initially in a voluntary capacity but later as a paid employee.

Some aids require very little training. NeuroPage, for example, requires the user to press a button when the message appears, and a trial run is carried out during the first meeting. If the user cannot press the button and act on the message, then the system is probably not suitable for that person. The cognitive prostheses described by Cole and Dehdashti (1990) and Cole (1999) are typically learned within three half-hour training sessions. For those familiar with mobile telephones, very little learning is required to respond to messages received by telephone. In the Fish et al. (2007) study described previously, each patient received a short training session (~30 minutes) using the cues to aid prospective memory performance.

**How Can We Best Measure the Effectiveness of External Memory Aids?**

The measures used to gauge the effectiveness of external memory aids are similar to those that apply to memory rehabilitation interventions in general: diaries of memory lapses, preferably kept by both the patient and the caregiver; rating scales and memory-symptom inventories; problem-solving inventories combining various scenarios that could involve the use of memory aids; and other indirect measures, such as blood levels associated with certain medications when a patient has difficulty remembering to take medication. Other measures may indirectly reflect the success of intervention: work-related goals (e.g., return to certain levels and amounts of work); greater independence in performing activities of daily living; reduced stress for the caregiver and the patient; improvements in measures of anxiety and depression; increased social and recreational participation; and so on.
How Can We Bring about Compliance and Generalization in the Use of External Memory Aids?

Instructing a patient on the use of memory aids in the clinic is all very well, but how can one ensure that the aids will be used, and used effectively, once the patient returns to domestic and work settings, and that they are still being used after several years? Home or work site visits will help in seeing where memory aids are located and in reorganizing any practical difficulties in implementing their use. Such visits may also encourage the patient to use external memory aids in community settings. In the case of the type of teaching carried out in the clinic, role-play sessions should ideally occur in environments such as kitchens, work stations, and so on, that are similar to those target settings where the aids will be used. The use of virtual reality systems when teaching the use of memory aids, ideally with photographs from home and work settings that are embedded in virtual reality software, may help to bridge the gap between the clinic and the community, and this remains an area to be explored in the future.

How Will Advances in Technology Impact Memory Aids of the Future?*

**Smart Homes**

Wilson and Evans (2000) and Cheek, Nikpour, and Nowlin (2005) noted the emergence of “smart houses,” where appliances are centrally controlled and include reminder functions that help prevent memory lapses (e.g., ensuring equipment is turned on or off). For example, refrigerators—typically one of the most commonly visited sites in a household—with built-in reminder and Internet facilities on the door are already on the market. Chan, Estève, Escriba, and Campo (2008) have reviewed a number of smart home projects and associated monitoring systems. They offered the following conclusions: “Smart homes need to integrate more fully their construction, computing infrastructure, and service delivery aspects. The proposed solution must match or exceed the patient’s standard of living. User habits and intentions should be studied in more detail and respected whenever possible. Further research is needed into legal and ethical problems, user and provider acceptance, and user and provider requirements and satisfaction” (2008, p. 76).

**Mobile Phones**

Mobile phones have become more sophisticated in terms of the range of functions that they perform and in the degree to which they can integrate with other devices, such as computers. Most mobile phones now have personal digital assistant features, and these may include, for example, a voice recorder, a diary, various alarm features, a camera, and a satellite navigation system. Although few mobile phones appear to have been designed with memory impaired or neurologically disabled people in mind, there are some with real or virtual QWERTY keyboards that may be easier to use for text entry purposes (Wright et al., 2000). Teaching memory-impaired patients to use mobile phones requires some thought and planning (Lekeu, Wojtasik, Van der Linden, & Salmon, 2002). The use of mobile phones to receive text message reminders has been shown to improve clinic attendance rates (Leong et al., 2006). Stapleton et al. (2007) found that a mobile phone could be helpful for some brain-injured patients as a means of prompting them to carry out certain targeted behaviors.

**Cameras**

Devices that automatically keep a photographic record of activities during the day, such as Microsoft’s SenseCam (Berry et al., 2007), may help to act as a pictorial diary to enable events to be reviewed and rehearsed at regular intervals after downloading onto a computer. The images may also act as cues to help retrieve forgotten memories. The advantages over general photographic devices is the automaticity of image production and the ability to readily categorize and retrieve images that are subsequently stored on computer. More generally, there may be developments in software that will enable video and other photographic records to be easily archived and readily retrieved and thus allow blogging to be interfaced with sophisticated data retrieval systems.

**Location Detection Devices**

Location detection devices to help find lost items at home have become more sophisticated in recent years, with radiofrequency- and radar technology-based devices now available in the market. It is possible that, in the future, radiofrequency identification devices may become miniaturized to the extent that they can be attached to items that are easily lost (e.g., eyeglasses) or to household items in general so that the owner can instantly locate the item.
Virtual Reality

Virtual reality procedures are beginning to impact on the discipline of neurorehabilitation (e.g., Merians, Poizner, Boian, Burdea, & Adamovich, 2006), and in the field of cognitive rehabilitation virtual reality software is being increasingly used to help bridge the gap between treatments in the clinic setting and activities in the patient’s home environment. Such software may also have a role in providing more ecologically valid assessments of areas such as prospective memory functioning. A few promising pilot studies have been carried out (Rose et al., 1999; Rose, Brooks, & Rizzo, 2005; Schultheis & Rizzo, 2001; Zhang et al., 2003), but more work needs to be done before the full benefits of virtual reality can be ascertained.

Advanced Brain Imaging

In general, advances in brain imaging and in memory rehabilitation have traveled along separate paths, with little in the way of cross-fertilization of data or ideas. There is, however, every reason to promote such interactions and to expect that they may occur in the future (cf. Strangman et al., 2008). Advanced structural and functional brain-imaging procedures may help to identify those individuals who might benefit from certain forms of memory rehabilitation (Strangman et al., 2008). Structural imaging, both in the form of gray matter status and fiber tract integrity, may provide a detailed profile of brain pathology and which areas are spared; and it is possible, for example, that comprehensive measures of frontal lobe or limbic–diencephalic integrity will help to predict which patients could benefit from mnemonic strategy training as opposed to external memory aids. As in the case of language rehabilitation (Peck et al., 2004), functional brain-imaging paradigms before and after a period of memory rehabilitation may provide useful information regarding the neural mechanisms underlying any changes that have taken place as the result of treatment (cf. Behrmann, Marotta, Gauthier, Tarr, & McKeeff, 2005; DeGutis, Bentin, Robertson, & D’Esposito, 2007). More speculatively, there is the prospect of online fMRI-mediated teaching of encoding and retrieval strategies, if we can generalize from some recent developments in neuroimaging (Weiskopf et al., 2004; Yoo et al., 2006).

In Chapter 11 we provide a selection of websites from which memory aids can be purchased.