CONCLUSIONS

The ability of clinicians to employ the principles of evidence-based practice in medical speech-language pathology has improved with the continued development of guidelines and systematic reviews and with the development of systems for rating these products. Although these projects provide clinicians with tools to improve clinical decision making, their ability to implement specific treatment techniques is hampered by limited access to the treatment literature and by insufficient translation of a printed description of a treatment into clinical practice. The development of a system to train students and clinicians to perform specific treatment procedures is proposed to improve treatment fidelity. Clinicians and researchers in the field of medical speech-language pathology are challenged to participate in the development of these programs. Readers interested in the possibility of such future collaboration may contact the author at the email address below.

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Evidence-Based Practice for the Use of External Aids as a Memory Compensation Technique

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This article is one of a series of publications by the Academy of Neurologic Communication Disorders and Sciences (ANCDS) on evidence-based practice (EBP) in the clinical management of neurogenic communication disorders. The EBP project was initiated in 1997 with the creation of expert committees charged with reviewing the literature in order to develop evidence-based clinical practice guidelines for a range of neurogenic communication disorders. The scope and mission of the EBP project are described in detail in previous publications (Golper et al., 2001; Yorkston et al., 2001). This article was generated by the subcommittee on cognitive-communication disorders associated with traumatic brain injury (TBI). Previous publications from this subcommittee include a clinical practice guidelines document on direct attention training (Sohlberg et al., 2003), a technical report (Turkstra

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et al., 2003) and an accompanying practice guidelines document on standardized cognitive-communicative assessment (Turkstra et al., 2005), an overview of clinical principles and assumptions about cognitive-communication disorders in a committee report (Kennedy et al., 2002), and a practical perspective on the application of evidence for clinical decision making (Ylvisaker et al., 2002). The EBP writing group also published a series of articles in an issue of *Seminars in Speech and Language* dedicated to evidence-based practice for cognitive-communication disorders after TBI (Turkstra, 2005).

The purpose of this article is to examine the literature on the efficacy of using external aids for the management of memory disorders in order to generate clinical recommendations for treatment providers. The degree and nature of persistent memory deficits vary among people with brain injury, although there are common patterns of impairment. For example, many individuals experience more difficulty storing and retrieving personal experiences than they do storing procedural information. Alternatively, memory deficits are often related to impairments in attention or working memory (Sohlberg & Mateer, 2001). External aids can compensate for a variety of memory impairments.

It is important to acknowledge the somewhat artificial nature of isolating cognitive impairments. The interdependence of attention, memory, and executive functions makes it difficult to independently evaluate the different cognitive operations and associated treatments, as activities that engage the neural circuitry for one process will by necessity activate circuits for other related processes (Flavell, Miller, & Miller, 2002). Memory impairments often co-occur with impairments in other cognitive domains (Sohlberg & Mateer, 2001). We further recognize the influence of emotional functioning on cognitive processes. The primacy of emotion and personality variables in recovery from cognitive impairments is only beginning to be acknowledged (Adams, 2003). Effective cognitive intervention requires that we remain mindful of the interactions among the different cognitive functions and the influence of emotional and contextual variables. These caveats notwithstanding, there are individuals for whom a significant impairment in memory is the predominant obstacle to performing everyday tasks. While we limit our report to the use of external aids to address memory impairments, we recognize that this intervention is also an approach used in the treatment of attention and executive function disorders.

REVIEW OF THE LITERATURE

Search Process

To develop evidence-based recommendations, the committee identified, classified, and analyzed the relevant literature. In order to identify relevant studies, the following databases were searched: PsychInfo, Medline, CINAHL, and ERIC. We combined terms that described brain injury including TBI, closed head injury, brain injury, and acquired brain injury with the term memory. We searched from the beginning date of each database through 2003. These results were combined with terms that describe treatment, including intervention, rehabilitation, therapy, remediation, and treatment. This resulted in 1,744 different articles.

We then narrowed the selection of articles to a total of 54 by applying the exclusion criteria described below. The memory intervention research literature was clearly divided into studies focusing on external memory aids versus those evaluating the use of internal memory strategies. The committee thus made the decision to separate the memory treatment outcome literature into two groups (a) the use of external memory aids (the current article) and (b) the use of internal memory strategies. Interestingly, our search revealed that many intervention studies on the use of internal memory strategies were published prior to 1990, but no studies on the use of external memory strategies were published prior to this. Next, abstracts or full articles were reviewed to eliminate reports that did not directly address the use of external aids as a memory intervention. Other exclusion criteria included: (a) theoretical articles or reports that did not include specific treatment studies and (b) reports without data. We included intervention studies that had included at least one subject with a TBI; this means that studies that included participants with other etiologies (e.g., stroke, viral encephalitis) *and* participants with TBI were included in this review. We made one exception to the last criterion and included one article that detailed memory notebook training for a participant who had suffered a stroke because the primary symptom was a dense anterograde amnesia (Squires, Hunkin, & Parkin, 1996).

This search process revealed 19 studies evaluating the effects of external aids as a memory compensation technique for the cognitively impaired population. The external peer review process exposed two more recent articles that met the selection criteria (Kirsch, Shenton, & Rowan, 2004a; Kirsch et al., 2004b) bringing the total evidence base to 21 articles (see Appendix A). Three survey studies were included and are listed in Appendix B, because they provided relevant information about use of external aids by people with cognitive impairments (Evans, Wilson, Needham, & Brentnall, 2003; Hart, Buchhofer, & Vaccaro, 2004) and barriers to using automated machines for people with brain injury (Crowe, Mahony, O'Brien, & Jackson, 2003). Appendix C is a glossary of terms used throughout the rest of this article, and Appendix D is a list of electronic devices and manufacturers that were referenced in the articles.

Organizing the Evidence

In general, the use of external aids is considered to be the most effective and widely used intervention for memory impairments after TBI (Quemada et al., 2003; Schmitter-Edgecombe, Fahy, Whelan, & Long, 1995; Sohlberg & Mateer, 2001; Wilson, Emslie, Quirk, & Evans, 2001; Zencius, Wesolowski, & Burke, 1990). External aids provide the user with a way to compensate for memory impairments by using a tool or device that either limits the demands on a person's impaired ability or transforms the task or environment to match the client's abilities. Other terms for external aids include cognitive orthoses, cognitive prosthetics, and assistive technology for cognition (Cole, 1999; Kirsch, Levine, Lajiness-O'Neill, & Schnyder, 1992; LoPresti, Mihailidis, & Kirsch, 2004). The literature describes a wide variety of aids, ranging in technical complexity and in the diversity of tasks or environments targeted by the device. For example, Kirsch et al. (1992) described a technical task guidance system specifically designed to increase the ability to complete janitorial duties. By contrast, Ownsworth and McFarland (1999) evaluated the efficacy of a "low tech" paper/pencil notebook system designed to improve memory functioning for a variety of tasks across environments (see LoPresti et al., 2004 for a review of devices and approaches to intervention using assistive technology).

In the committee's initial article reporting on evidence-based practice guidelines for the use of attention training, a template consisting of four key questions was used to analyze the literature and generate clinical guidelines that would be useful to practicing clinicians (Sohlberg et al., 2003). These key questions were applied to the external aid literature and served as a schema for organizing the information coded for each article, as shown in Appendix A (Tables I–IV). The key questions and subordinate categories that guided the committee's examination of the literature were the following:

1. Who were the *participants* who received the intervention? (Appendix A: Table I)
   - How many individuals were involved in the study and what were the inclusion or exclusion criteria used in recruitment?
   - What were the participant demographics (age, gender, education, race, family status, occupation, motor and sensory functions, etc.)?
   - What was the diagnosis or etiology?
   - What was the site of injury? What was the severity of injury?
   - Were there dual diagnosis or comorbidity factors at the time of the injury?
   - What was the time postonset of injury?
   - What was the participant's cognitive profile postinjury? Was cognitive intervention provided postinjury?
   - What was the medication profile?
2. What comprised the external aid intervention? (Appendix A: Table II)
   - What were the focus and rationale?
   - What type of external aid was used?
   - What training was provided?
   - What was the training duration and frequency?
   - Where was the treatment setting?
   - Who were the providers?
   - What dependent variables were used to measure use of aids?
   - How were generalization and maintenance addressed?
3. Were there methodological concerns? For example, were there other explanations for given outcomes, and could results be either exaggerated or hidden? (Appendix A: Tables I–III)
   - What was the study design?
   - What controls were in place? Were treatments compared to an alternative or no-treatment condition?
   - Was validity addressed?
   - How were data quantified or analyzed statistically?
4. What were the *outcomes* of the intervention? (Appendix A: Table IV)
   - Were there changes in memory impairment (e.g., on psychometric tests) following treatment?
   - Were there changes in level of activity or participation in functional everyday tasks related to either memory or changes in the use of the external aid (World Health Organization International Classification of Function, Disability and Health, 2001, www3.who.int/icf/icftemplate.cfm)?
   - How did the authors interpret the results and outcomes of their studies?

- Based on the study, did the authors call for future research?

Ten of the 21 research studies were reviewed independently by the second and third authors to check for reliability in coding. There were no consistent discrepancies, and differences were largely concerned with interpreting the depth of details provided or with category definitions (e.g., whether "percentage correct" was considered a statistical analysis). Percent agreement for codes entered in the tables was 87% and deemed acceptable. All differences were resolved by discussion.

Who Were the Participants in the Studies?

The 21 studies included a total of 270 participants (Appendix A: Table I). The majority of participants were adult males and most were in the chronic stage postinjury. Four studies included adolescents or children (Kerns & Thompson, 1998; Schmitter-Edgecombe et al., 1995; Quemada et al., 2003; Wilson et al., 2001). Etiology varied greatly and included brain injuries due to trauma, disease, and stroke. One study (Wilson et al., 2001) included participants with brain damage occurring from progressive illnesses. While not always reported, premorbid occupation, educational level, and postinjury living situations spanned a wide range. The latter included residential care facilities, acute care rehabilitation facilities, community living with carers, and independent living. All participants were English speakers with the exception of the Japanese-speaking participants in one study (Yasuda et al., 2002) and Spanish speakers in another study (Quemada et al., 2003). Few authors reported variables such as cormorbidity, concurrent motor or visual impairments, initial severity, previous cognitive intervention, IQ, or medication profile.

All study participants were described as having significant memory impairments (usually including prospective memory deficits) that affected their level of independence in daily functioning. Nineteen of the studies provided scores from neuropsychological or general disability testing to verify significant levels of memory impairment, whereas two did not (Burke, Danick, Bemis, & Durgin, 1994; Fluharty & Priddy, 1993). Five of the studies described additional cognitive-linguistic impairments including difficulty with planning and organization.

Individual participant characteristics that might affect successful adoption of an external aid were not reported or evaluated in the studies. There was some suggestion that a person's level of self-awareness and insight was a critical predictor of outcome (Ownsworth & McFarland, 1999) and that client beliefs and attitudes may influence the treatment outcomes (e.g., Fluharty & Priddy, 1993). The most rigorous experimental evaluation of the reviewed studies reported success in the use of a pager system that places minimal demand on the user's insight or awareness (Wilson et al., 2001). On the other hand, successful implementation of devices was also reported with resistant clients (Squires et al., 1996).

The synthesis of data was limited by the heterogeneity across participants and the lack of details regarding participant characteristics such as comorbid conditions. An important consideration, however, is that all studies focused on individuals whose memory impairments significantly disrupted their daily functioning.

What Comprised the External Aid Intervention?

The focus of all of the studies was the effectiveness of using an external aid (Appendix A: Table II). Several studies compared the effects of external aid use with the use of other memory interventions or with the individual's memory functioning when the aid was not available (Kirsch et al., 2004a; Kirsch et al., 2004b; Schmitter-Edgecombe et al., 1995; Quemada et al., 2003; Zencius et al., 1990). One study compared the effectiveness of two types of external aids (Wright et al., 2001). Two studies specifically compared methods for training participants in the use of aids (Donaghy & Williams, 1998; Ownsworth & McFarland, 1999). Although not always explicitly stated, the rationale for the external aid intervention in all of the studies was as a compensatory strategy, rather than treatment of the memory deficit per se.

Types of External Aids

A survey by Evans et al. (2003) showed that memory notebooks were the most commonly used memory aids among people with brain injury, and that electronic aids were used infrequently. These authors speculated that most existing electronic aids were too complex for people with significant memory problems and that rehabilitation professionals did not routinely recommend or train such devices. Another survey study (Hart et al., 2004) found that although portable electronic devices were not in common use, consumers with significant disability due to TBI rated them as acceptable and desirable memory aids. (See Appendix A.)

Of the 21 studies reviewed for this article, the most common type of external aid was a written memory notebook or diary planner (9 studies). The remainder of the studies evaluated electronic aids: four studies evaluated the use of electronic memory hand-held calendar devices (Kim, Burke, Dowds, & George, 1999; Kim, Burke, Dowds, Boone, & Park, 2000; Kirsch et al., 2004b; Wright et al., 2001); three investigated the use of voice organizers as a prompting system (Hart, Hawkey, & Whyte, 2002; van den Broek, Downes, Johnson, Dayus, & Hilton, 2000; Yasuda et al., 2002); three evaluated the use of a pager (Kirsch et al., 2004a; Wilson, Evans, Emslie, & Malinek, 1997; Wilson et al., 2001); one evaluated the use of mobile phones (Wade & Troy, 2001); and one evaluated a customized task guidance system (Kirsch et al., 1992).

Training in the Use of External Aids

The authors of a study must include sufficient methodological details for researchers to replicate a study and for clinicians to apply a technique to their practice, particularly details about device training procedures. Details regarding training methods varied widely among the 21 studies. Fourteen of the studies reported some degree of training; this group included the 9 studies that evaluated memory notebooks. Six of the studies reported that participants received either no training or a simple demonstration.

Several reports described principles and procedures for instructing individuals with memory disorders to use memory aids. These training protocols tended to be founded in instructional practices from the special education literature. For example, Schmitter-Edgecombe and colleagues (1995) incorporated both behavioral learning principles and educational strategies in an individualized training program for each client receiving memory notebook training. They augmented the behavioral training sequence of Sohlberg and Mateer (1989) and described four training stages: anticipation, acquisition, application, and adaptation. Within each stage, didactic lessons and homework assignments were presented by the therapists and incorporated into a "Learning Activities Packet" to reinforce learning.

Donaghy and Williams (1998) described training procedures that facilitated error-free learning during an acquisition phase and gave the learner adequate practice with each of the notebook procedures. They, too, refined the Sohlberg and Mateer (1989) training model and simplified the structure of the notebook that was trained.

A number of the studies did not fully explain the type of instruction that was provided (e.g., Hart et al., 2002; Yasuda et al., 2002). For example, in their evaluation of the Voice Organizer, van den Broek et al. (2000) reported only that participants were trained to use the device at the beginning of the experimental phase, with no information about the nature of that training. Similarly, in their randomized controlled trial, Wilson and colleagues (2001) reported that many of the participants needed training with the pager from a caregiver before they were able to derive a benefit; those who were more impaired needed help over a longer period of time. The type of training, however, was not specified. In their evaluation of electronic memory aids, Wright and colleagues (2001) reported providing participants with minimal introduction in the use of the device; training consisted of one office visit in which the researchers demonstrated how to use the device, followed by an additional visit 1 week later. In contrast, Ownsworth and MacFarland (1999) acknowledged the importance of systematic training for successful use of a memory notebook; however, as in the Wilson et al. (2001) study, the training was carried out by carers in the natural environment and was not monitored by researchers. The authors instead provided instructions in the mail and via phone support.

There are several possible reasons that many authors did not report or emphasize training procedures. First, some participants may have needed little training. For example, the participants in the Wright et al. (2001) study had relatively mild cognitive impairments compared to those in the other studies; thus training may not have been as critical. Second, when training was implemented by carers in natural contexts, it might not have been possible to know how much and what type of training was provided. Finally, the successful use of devices with seemingly little training may have been due to the nature of the task targeted by the external aid. For example, the Neuropage evaluated by Wilson and colleagues was used to cue a target discrete behavior (e.g., taking medication). By contrast, memory books or electronic devices designed to assist with organizing, initiating, and planning multiple prospective tasks during the day are multipurpose and place a greater demand on the learner (Wright et al., 2001).

Outcomes: Measurement of Participant Behavior

The literature review revealed a broad range of outcome measures to evaluate the use of external aids (Appendix A: Table IV). Most studies used several measures to gain a picture of effectiveness and client satisfaction. The following seven categories cap-

ture the different types of dependent measures used in the literature:

- Laboratory-based memory measures (Donaghy & Williams, 1998; Kerns & Thomson, 1998; Quemada et al., 2003; Schmittter-Edgcombe et al., 1995; Wilson et al., 2001; Wright et al., 2001)
- Performance on structured tasks designed to capture the demands of everyday memory (van den Broek et al., 2000)
- Retrospective questionnaires assessing everyday memory performance (Donaghy & Williams, 1998; Hart et al., 2002; Ownsworth & McFarland, 1999; Quemada et al., 2003; Schmitter-Edgecombe et al., 1995; Wilson et al., 2001)
- Performance on memory tasks cued by the aid (Kim et al., 1999; Kerns & Thomson, 1998; Kirsch et al., 1992; Squires et al., 1996; Kirsch et al., 2004a; Kirsch et al., 2004b; Wade & Troy, 2001; Wilson et al., 1997; Wilson et al., 2001; Yasuda et al., 2002; Zencius et al., 1990)
- Frequency of use of external aids (e.g., number of calendar entries) (Ownsworth & McFarland, 1999; Schmitter-Edgecombe et al.,1995; Wilson et al., 2001; Wright et al., 2001; Yasuda et al., 2002)
- Ratings of participant preference, satisfaction, or perception of memory performance (Kim et al., 2000; Ownsworth & McFarland, 1999; Schmitter-Edgecombe et al., 1995; Wilson et al., 2001; Wright et al., 2001)
- Anecdotal reports of effectiveness of the aid (Burke et al., 1994; Fluharty & Priddy, 1993).

A number of the studies underscored the importance of measuring the functional impact of the external aid. They encourage including a measure of performance on the actual tasks being cued by the memory device (e.g., Quemada et al., 2003; Schmitter-Edgecombe et al., 1995).

Are There Methodological Concerns?

Level of Evidence

Efficacy studies have been categorized according to the class or type of evidence by the Oxford Center for Evidence-Based Medicine (http://cebm.jr2.ox.ac.uk/docsw/levels). Class I evidence refers to well-designed, prospective, randomized controlled trials (RCTs). Class II evidence derives from prospective, nonrandomized, cohort studies; retrospective, nonrandomized, case-control studies; clinical series with well-designed controls that permit between-subject comparisons of treatment conditions or within-subject controlled experiments (e.g., multiple-baseline design across behaviors). Class III evidence includes case studies or single subject studies without adequate controls (Miller et al., 1999; Yorkston et al., 2001). Of the 21 studies on the use of external aids, 10 were categorized as Class II studies (Appendix A: Table III). Of these, 6 used within-subject experimental designs in which the participants acted as their own controls, and 4 used group comparison designs. Ten studies were considered to provide Class III evidence.

The NeuroPage study of Wilson and colleagues (2001) was the only Class I experiment on the effectiveness of external aids. These researchers conducted an RCT involving a crossover design. Participants were 143 people between the ages of 8 and 83 years, all of whom had memory, attention, or organizational problems primarily caused by TBI. Participants were provided with paging systems that reminded them to carry out self-selected functional tasks. More than 80% of the participants who completed the 16-week trial were significantly more successful in carrying out these everyday activities (e.g., self-care, self-medication, and keeping appointments) when using the pager in comparison to the baseline period. For most of the participants, improvements were maintained when they were monitored 7 weeks after returning the pager, suggesting that external prompting resulted in establishing the desired behavior. The authors concluded that the paging system reduced everyday failures of memory and planning among the participants. A methodological concern was the absence of reliability measures: there was no verification of the accuracy of the daily recordings or the completion of the targeted behavior(s) and no report of assessing procedural reliability to ensure that training or device use was uniform.

A review of the studies in Appendix A: Table III reveals a number of methodological concerns. Many studies lacked subject and treatment descriptions that would be critical for replication. There is a need for more detailed information on the nature and level of the participants' memory impairments, and on previous and concurrent cognitive interventions, in order to evaluate candidacy for future participants. Further, as discussed previously, the lack of information on training or methods for introducing the external aids limited the interpretability and clinical applicability of reported findings. As is found throughout the rehabilitation literature, there was a lack of objective, validated measurements to assess functional outcomes. Few studies contained adequate experimental control, further weakening the evidence base.

It is recognized that more rigorous, systematic investigations need to be carried out that contain adequate reliability and validity. A goal of the current report is to glean clinically relevant information from the existing studies while determining the needs for future research.

On a positive note, in studies published within the last decade, there was a trend toward increased experimental control and the use of well-defined, functional outcomes. It must be remembered, however, that the heterogeneity of the population and the need to consider the unique ecology of every person with a brain injury renders Class III evidence helpful in guiding efficacy research, even though the generalization of findings to a larger population may be limited (Golper et al., 2001).

How Strong is the Evidence?

For a rehabilitation treatment to be considered a *practice standard*, the research evidence should be comprised of at least one well designed Class I study with additional very strong Class II studies that directly address the effectiveness of the treatment in question (Miller et al., 1999). A *practice guideline* is appropriate if the research supports a moderate degree of clinical certainty, usually based on Class II studies or a strong consensus from Class III evidence. An analysis of the research related to the use of external aids provides evidence that clearly meets the criteria for a practice guideline. Every study included in this analysis described improved functioning on memory-related activities in association with the implementation of external aids. Thus, treatment directed toward establishing use of external aids for memory compensation may be considered a *practice guideline* for individuals with brain injury. The reported positive outcomes included increased independence in general activities of daily living (e.g., Fluharty & Priddy, 1993; Ownsworth & McFarland, 1999; Schmitter-Edgecombe et al., 1995), improved performance on tasks such as getting to therapy or class on time (Kerns & Thompson, 1998; Kim et al., 1999; Kirsch et al., 2004a), a reduction in the amount of repetitive questioning (Squires et al., 1996), improved navigation (Kirsch et al., 2004b; Quemada et al., 2003), and improved performance on a vocational task (Kirsch et al., 1992). Despite the diversity in outcome measures, there was a uniform finding across studies that the use of external aids directly resulted in improved day-to-day functioning. However, given the lack of specificity on issues related to candidacy, selection of aids, training, and the lack of evaluation of generalized and continued use of aids, the literature does not yet support the use of external aids as a *practice standard*.

Training methods were broadly discussed, but few details were provided. None of the studies with the exception of Ownsworth and McFarland (1999) directly addressed the influence of the amount or nature of instruction on outcomes. However, a number of studies emphasized the importance of individualizing the training and selection of aids (e.g., Burke et al., 1994; Donaghy & Williams, 1998), and many reported that it was useful to provide direct, systematic, instruction when implementing an external aid for participants with moderate to severe memory impairments (e.g., Fluharty & Priddy, 1993; Hart et al., 2002; Kerns & Thomson, 1998; Kim et al., 2000; Ownsworth & McFarland, 1999; Quemada et al., 2003; Schmitter-Edgecombe et al., 1995; Squires et al., 1996; van den Broek et al., 2000; Wright et al., 2001; Zencius et al., 1990). The writing committee for this article is currently investigating the evidence for the effectiveness of different instructional practices, including systematic instruction, for teaching procedures and information to people with significant cognitive impairments (Sohlberg, Ehlhardt, & Kennedy, 2005).

Generalization and maintenance were rarely addressed in the literature reviewed. Several studies noted a continuation of a target behavior following withdrawal of a device that cued participants to complete the specified task (Kirsch et al., 2004; Wilson, et al., 2001). Only one study (Kim et al., 2000) evaluated long-term outcomes. Kim and colleagues surveyed participants about the utility of palmtop computers to assist with memory-dependent activities 2 months to 4 years after initial introduction of the aid during outpatient treatment. The authors found that 7 out of 9 participants continued to use the devices long after the initial study had ended. In general, issues related to long-term adoption of external memory aids have yet to be explored in the rehabilitation literature.

While the basic outcome question "Are external aids helpful?" can be answered affirmatively, critical questions related to candidacy, device selection, user evaluation and specific training protocols have yet to be answered.

SUMMARY

The research to date underscores the potential of external aids to improve the daily functioning of people with memory impairments. The studies are universally supportive of the general practice of using external aids to compensate for memory impairments, but lack sufficient evaluation of critical treatment implementation parameters to support a practice standard. Thus, our committee recommends the use of external aids in the treatment of memory impairments as a rehabilitation practice guideline for adults with memory impairment following TBI.

A critical research gap is the lack of information on factors that lead to long-term adoption of external aids. There is a great need for research that avoids the methodological concerns noted in the current literature pool in order to deepen our understanding of the broad spectrum of variables necessary for successful use of external aids in the memory-disordered population. Research needs to address questions related to the design and selection of aids (including both high- and low-tech devices designed for people with cognitive disabilities and aids such as palmheld devices and notebooks that are designed for the general population) and the evaluation, instruction, and ongoing monitoring of people using the devices. Research on user patterns and device acceptance in the field of augmentative and alternative communication may offer models for studying memory aid use. We conclude this report with a list of specific research questions that must be addressed before more detailed practice guidelines can be generated.

1. What are the individual and environmental factors that affect the long-term, continuous use of various types of external aids by persons with memory impairments?
2. What are the evaluation components that lead to the selection (and customization) of the most appropriate aids or devices for an individual with a memory impairment?
3. What are the training components most likely to lead to efficient, durable use of an external aid?
4. When individuals successfully use external aids, what are the best indicators to capture the aids' impact on daily functioning?
5. Which clients need explicit generalization training?
6. How can we facilitate generalization of the use of external aids across various aspects of our clients' everyday life?

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APPENDIX A. Evidence Base Tables. Table I. Participant Characteristics

Author	Focus	Number	Age in Years (Range)	Male/ Female	Education (Range in Years)	Pre- or Postmorbid Occupations	Postinjury Living Situation	Family Status
Burke et al. (1994)	Effect of a new approach to memory book training	1	NP	1/0	NP	An average student who achieved below his potential	Transferred to residential TBI program after psych admit	NP
Donaghy & Williams (1998)	Effect of memory book training	2	47 and 36	1/1	NP	NP	NP	NP
Fluharty & Priddy(1993)	Effect of using memory aids	1	59	1/0	2 years of college	Employed for 35 years in a publishing company; last 5 years as a supervisor	Lived alone in an apartment	Daily affairs supervised by his children
Hart et al. (2002)	Effect of using electronic memory aid	10	M: 31.5 (19–45)	8/2	(11–16)	NP	NP	NP
Kerns & Thomson (1998)	Effect of using memory aids	1	13	0/1	Eighth grader	A student with good academic performance	NP	NP
Kim et al. (1999)	Effect of using memory aids	1	22	1/0	NP	NP	NP	NP
Kim et. al. (2000)	Effect of using memory aids	12	M: 49.6 (22–67)	8/4	High school: 4 Associate degree:1 Bachelor: 4 Master: 3	NP	NP	NP

(-) = None; NP = Not provided; NA = Not applicable; M = Mean

All studies used English-speaking participants except the Japanese speakers in the Yasuda et al. (2002) study and the Spanish speakers in the Ouemada et al. (2003) study.
Race was not reported in any study except Yasuda et al. (2002).

continues

APPENDIX A. *continued*

Author	Focus	Number	Age in Years (Range)	Male/ Female	Education (Range in Years)	Pre- or Postmorbid Occupations	Postinjury Living Situation	Family Status
Kirsch et al. (1992)	Effect of using electronic memory aid	4 (initially had 7)	(22–55)	NP	NP	3 employed before injury. 1 unemployed	All lived in treatment facilities	NP
Kirsch et al. (2004a)	Use of alphanumeric paging system to cue use of daily planner	1	Mid 30s	1/0	NP	NP	NP	NP
Kirsch et al. (2004b)	Evaluate use of web-based content on iPAQ to guide completion of functional tasks	2	19 and 71	1/1	High school and 16 years	NP	Day treatment program. Lived at home w/ family.	Single w/family support
Ownsworth & McFarland (1999)	Effect of using diary on episodic memory	20 (selected from 30)	M = 43.1 (23–65)	19/1	M: 1.6	NP	NP	NP
Quemada et al. (2003)	Effect of cognitive retraining strategies and external aids	12	M: 33.1 (15–65)	6/6	NP	NP	NP	NP
Schmitter-Edgecombe et al. (1995)	Comparing notebook training with supportive therapy	8 Divided into two groups (Notebook vs. Support)	Notebook M: 29.9 Support M: 26.8 (17–55)	6/2	Notebook M: 14.5 Support M: 13.5	NP	NP	NP
Squires et al. (1996)	Effect of using memory aids	1	70	1/0	NP	NP	Lived with wife	NP
Van Den Broek et al. (2000)	Effect of using electronic memory aid	5	(25–56)	4/1	NP	NP	NP	NP
Wade & Troy (2001)	Effect of using mobile phones as memory aids	5	(18–51)	3/2	NP	1 subject in paid employment	All lived with family member	NP

Wilson et al. (1997)	Effect of using memory aids	15 (20 in initial group, 5 w/ drew)	(19–66)	11/4	NP	None in paid employment	Lived with family: 12; lived alone: 2; long-term residential care: 1	NP
Wilson et al. (2000)	Effect of using memory aids	143 completed all stages (198-Referrals)	M = 38.57 (8–83)	105/38	NP	93.7% not in paid employment	Residential care/hospital: 4.2%; lived with family: 72%; lived alone with help: 12.6%; lived alone: 11.2%	NP
Wright et al. (2001)	Effect of using external memory aids	12	M: 34 (22–54)	6/6	NP	NP	NP	NP
Yasuda et al. (2002	Effect of using electronic memory aid	8	(23–57)	4/4	(9–16)	NP	All but one lived with family	NP
Zencius et al. (1990)	Comparing 3 memory retraining strategies with external memory aids	6 divided into two groups	(24–30)	3/3	NP	NP	NP	NP

continues

APPENDIX A. *continued*

Author	Time Postonset (Range)	Etiology	Site of Injury	Dual dx/ Comorbity	IQ	Initial Severity
Burke et al. (1994)	NP	TBI	NP	NP	NP	NP
Donaghy & Williams (1998)	~5 mos	SAH: 1; pituitary tumor: 1	NP	NP	NP	NP
Fluharty & Priddy (1993)	Not specifically described.	Aneurysm	SAH (right frontotemporal area)	(-)	NP	NP
Hart et al. (2002)	>1Y (13mos—18Y): 9 within 3mos: 1	TBI	Incomplete: Bifrontal edema:1; right frontal contusion: 1; SAH and interventricular hemorrhage: 1; left SDH: 1	(-)	NP	GCS ranged from 3–15
Kerns & Thomson (1998)	Vision difficulty at age 6; calcified astrocytoma diagnosed at age 8	Calcified astrocytoma	Optic chiasm & hypothalamic area extending into 3rd ventricle	(-)	WISC-R (FSIQ=119; VIQ=117; PIQ=114)	NP
Kim et al. (1999)	2 months	CHI with multiple orthopedic injuries	DAI & left ventricle hemorrhage	NP	WAIS-R: VIQ=58; PIQ=57	At admit: open 1 eye; At rehab: RLA III
Kim et al. (2000)	4 months–11Y	TBI: 11 (9 = MVA: 9; Fall: 2); CVA: 1	Varied	NP	WAIS-R	NP
Kirsch et al. (1992)	(1–10Y)	MVA	NP	1 with history of psychiatric disturbance	Postmorbid Full Scale IQ ranged from 66–74	Length of coma ranged from 3–15 days
Kirsch et al. (2004a)	30 days	TBI	Right frontal parietal SDH removed by right frontal craniotomy	NP	NP	Initial GCS: 13 deteriorating to 7

Kirsch et al. (2004b)	#1–6 mos #2—1Y	#1—TBI; #2—TBI and previous stroke	#1—right frontal/brainstem; #2—multiple small white matter lesions c/w ischemic disease	#1—NP #2— history of depression.	NP	Severe
Ownsworth & McFarland (1999)	M = 15Y (4–37Y)	MVA: 12; Sport injury: 1; Assault: 2; Tumor: 2; Stroke: 1; Infection: 1	Right occipital, left occipital, left frontal, right frontal, diffuse	NP	NP	Duration of PTA ranged from 0 to >8 weeks
Quemada et al. (2003)	NP	TBI	Left-sided lesion: 3; right-sided lesion: 4; bilateral or diffuse: 5	NP	NP	Initial mean GCS: 5.7; PTA >28 days
Schmitter-Edgecombe et al. (1995)	Notebook M: 77.7 months; support M: 86.8 months	TBI	NP	NP	Notebook G. M: 92; Support G M: 95.2	Length of Coma M: 39.7 days
Squires et al. (1996)	Most recent > 3 yrs	2 CVAs	Lesion in the posterior limb of the right int. capsule, right parietal lobe, and ischemic changes	NP	WAIS-R: (FSIQ=101; VIQ=105; PIQ=97)	Severe prospective memory impairment
Van Den Broek et al. (2000)	At least 12 mos	Encephalitis: 2; SAH: 1; CHI: 1	NP	NP	NP	NP
Wade & Troy (2001)	1–15Y	CHI	Right int. capsule and right frontal lobe: 1; hemorrhage contusions to both frontal lobes and blood in left ventricle: 1; no focal lesion: 1; left postparietal region: 1; multiple white matter contusions: 1	NP	Postmorbid Full Scale IQ ranged from 63–96	2/5 with severe head injury
Wilson et al. (1997)	6 mos–13Y	Head injury: 10; CVA: 1; SAH: 2; Tumor: 1; Colloidal cyst: 1	NP	1w/2nd SAH 2 weeks prior to study	NP	NP
Wilson et al. (2000)	M:4.9Y	TBI:44.1%; Stroke: 25.2%; Acquired nonprogressive BI:14.6%; Acquired progressive BI:7.0%; Others: 9.1%	NP	NP	NP	NP

continues

APPENDIX A. *continued*

Author	Time Postonset (Range)	Etiology	Site of Injury	Dual dx/ comorbity	IQ	Initial Severity
Wright et al. (2001)	M: 6Y (2–12Y)	TBI	NP	NP	NP	NP
Yasuda et al. (2002)	2–25 months	CsHI: 4; SAH: 2; Tumor: 1; Multi: 1.	Bifrontal, DAI, right frontal and left occipital lobe	NP	Postmorbid General WMS ranged from untestable to 86	NP
Zencius et al. (1990)	TPO provided for 2 participants: 6 & 8 years	MVA	Partial: provided for 3/6 subjects (left frontal contusions & bilateral frontal SDH)	NP	NP	NP

Author	Neuropsychological Testing (NPsT)*	Selection/Exclusion Criteria; Attrition	Cognitive Tx history	Meds	Motor Function	Hearing/ Vision
Burke et al. (1994)	No NPsT provided. Report of difficulty with impulse control, memory, confusion, social judgment, self-centeredness, awareness, and attention	NP	After 4 weeks, subject was transferred to a brain injury rehabilitation center for 5 month stay	NP	NP	NP
Donaghy & Williams (1998)	Severe memory deficits (< 1st %ile on memory probe)	NP	NP	NP	Wheelchair: 1; ambulated independently:1	One with no right eye vision & left temporal field cut
Fluharty & Priddy (1993)	No NPsT provided. Report of severe prospective memory impairment	NP	Postacute residential treatment	Low dose of antidepression medication	NP	NP

Hart et al. (2002)	No NPsT provided. Functional evaluation via Comprehensive Outpatient Rehabilitation Evaluation (CORE)	Inclusion criteria: memory impairment, difficulty with remembering tx goals, no severe receptive or expressive language deficits, involved in tx. program for 2–5 days per week.	Community reentry program or clubhouse day program	NP	NP	NP
Kerns & Thomson (1998)	Significant memory and attention difficulties: WRAML, DFRT, WRAT-R	NP	NP	Chemotherapy	NP	Right upper quadrant visual field loss
Kim et al. (1999)	Report of significant cognitive-linguistic deficits. WAIS-R scores below borderline	NP	Intensive inpatient rehabilitation for 1 month	NP	Independent with wheelchair	NP
Kim et al. (2000)	Prospective memory impairment: WAIS-R.	36 subjects enrolled initially; 12 available for follow-up.	NP	NP	NP	NP
Kirsch et al. (1992)	Significant memory impairment: WMS and List-Learning Tasks	3 subjects discontinued	NP	NP	NP	NP
Kirsch et al. (2004a)	Significant memory and executive impairments: WAIS-III, WMS-R, CVLT, TRLSAB, WCST, Verbal Fluency, Tapping, Grooved Pegs	NP	NP	NP	NP	NP
Kirsch et al. (2004b)	Both participants had severe memory and executive function impairments: WMS-R, CVLT-II, TRLSAB, WCST, Tapping	NP	#1 = acute/ inpatient rehab for 4 mos #2 = residential TBI facility for 8 mos	#1 = NP #2 = trazodone	NP	NP
Ownsworth & McFarland (1999)	Significant prospective memory impairment: WMS-R and RMBT	NP	NP	NP	NP	NP

continues

APPENDIX A. *continued*

Author	Neuropsychological Testing (NPsT)*	Selection/Exclusion Criteria; Attrition	Cognitive Tx history	Meds	Motor Function	Hearing/ Vision
Quemada et al. (2003)	Severe memory impairment: REY, CVLT, RBMT, and MFE	Inclusion: TBI, <40%ile on CVLT + REY, no neuropsychiatric or sensory condition interfering with treatment. Exclusion: < 75 on WAIS	NP	NP	NP	NP
Schmitter-Edgecombe et al. (1995)	Significant prospective memory impairments: WMS-R, RBMT, EMQ, and DRS	Selection criteria: age, education, length of coma, age at injury, TPO, and IQ Exclusion: CD, psychiatric diagnosis, use of external aids	No use of external aids	NP	NP	NP
Squires et al. (1996)	Dense anterograde amneasia and prospective memory impairment: WMS-R, RAVLT and WRMT	NP	NP	NP	NP	NP
Van Den Broek et al. (2000)	Significant prospective memory impairment: RBMT and PANAS	Selection criteria: clinical evidence of prospective memory impairment, ≥12 mos TPO, no prohibitive motor or sensory conditions, no premorbid LD or psychiatric conditions, willing careprovider	NP	NP	NP	NP
Wade & Troy (2001)	Significant prospective memory impairment: RBMT, BADS, NART.	Selection criteria: for whom a memory aid was deemed appropriate	NP	NP	1 with right hemiplegia	NP
Wilson et al. (1997)	Mild to severe memory deficits and everyday memory problems, e.g., poor attention, planning and organizational skills: RBMT	1 d/c re: lack of belief of poor memory; 1 unable to keep baseline; 2 w/ maximum dependency on others; 1 unable to complete training	NP	NP	NP	NP
Wilson et al. (2000)	Significant memory, planning, and organizational difficulties: TEA, RBMT, SCOLP, and Modified 6 Elements Subtests from BADS	Broad self-referral; anyone w/memory and/ or planning difficulties (either congenital or acquired) but needed to read and keep records; some degree of insight	NP	NP	NP	NP
Wright et al. (2001)	Significant prospective memory impairment: NART, SCOLP, RBMT and BADS	Exclusions: individuals with visual or motor impairment	NP	NP	Without motor handicaps	No visual impairment
Yasuda et al,(2002)	Significant prospective memory impairment: WAIS-R and WMS-R	Selection criteria: reported prospective memory impairment	NP	NP	NP	NP
Zencius et al. (1990)	Significant memory deficits, cognitive impairment, and emotional problems: PPVT, EOWPVT	NP	NP	NP	3 with hemiparesis, 1 with impaired balance and coordination	Partial list: 1 with loss of peripheral vision; 1 blind in left eye

continues

APPENDIX A. Evidence Base Tables. Table II. Treatment

Author	Focus	Number	Treatment Rationale	Type of Aid	Type of Training	Tx Setting	Training Duration and Frequency
Burke et al. (1994)	Effect of a new approach to memory book training	1	Comp.	Daytimer memory book	Direct training including awareness training, modeling and behavioral contracting	NP	NP
Donaghy & Williams (1998)	Effect of memory book training	2	Comp.	Memory book	The Alberta Hospital Ponoka (AHP) memory journal training programme: Direct training (sequenced instruction with practice)	NP	Case1: three 30-min sessions per week for 9 wks; Case 2: d/c of tx
Fluharty & Priddy (1993)	Effect of using memory aids	1	Comp.	Daytimer memory book	Direct training plus awareness training. Focus on the use of journal and journal entry skills (both individual and group sessions)	Postacute residential head-injury program	NP
Hart et al. (2002)	Effect of using electronic memory aid	10	Comp.	Voice Organizer: Parrot Voice Mate III	Individualized training provided before 1-week trial	NP	Continued until subjects demonstrated the ability to play a message (all within 3 training sessions)
Kerns & Thomson (1998)	Effect of using memory aids	1	Comp.	Memory Notebook	Direct training: 1. Acquisition stage to understand the contexts and sections of notebook; 2. Application stage to actually record during school days; 3. Adaptation phase to modify and adapt the memory system to the functional setting	Home & School	Acquisition:4.5 wks; Application: 3 wks; Adaptation stage: 2 wks (Total = 9.5 wks)
Kim et al. (1999)	Effect of using memory aids	1	Comp.	Electronic memory aid: PSION series 3a palmtop computer	Demonstration was provided but no training. (Began w/ appt. info. and added medication info. after 5 days)	Inpatient hospital	NA
Kim et al. (2000)	Effect of using memory aids	12	Comp.	PSION series 3a palmtop computer	Direct training to use Palmtop computer	NP	Supervised training conducted twice weekly
Kirsch et al. (1992)	Effect of using electronic memory aid	4 (initially had 7)	Comp.	Computer-assisted interactive task guidance (ITG)	Demonstration was provided but no training	NP	NA
Kirsch et al. (2004a)	Use of alphanumeric paging system to cue use of daily planner	1	Comp.	Alphanumeric pager	Trials of pager	Day treatment program	Once each program day over 9½ weeks (N = 21)
Kirsch et al. (2004b)	Evaluate use of Web-based content on iPAQ for assisting with functional tasks	2	Comp.	#1 IPAQ cueing route directions; #2: IPAQ w/cueing substeps to use alarm clock	Informal exposure to devices	Day treatment program	Several informal trials
Ownsworth & McFarland (1999)	Effect of using diary on episodic memory	20 (selected from 30)	Comp.	1. DO: Diary only 2. DSIT: Diary plus self-instruction training	DO: task specific training (via letter, booklet, phone); DSIT: training higher cognitive skills of self-awareness and self-regulation (via phone)	In home	DO: 4 weeks (baseline 2 wks); DSIT: 4 weeks (baseline 6 wks)

Comp = Compensatory

continues

APPENDIX A. *continued*

Quemada et al. (2003)	Effect of cognitive retraining strategies and external aids	12	Retraining and comp.	Wilson's structured behavioral memory programs: Personalized memory aids (e.g., notebook) plus reorganization and restoration technique	Direct training to use of memory aids (e.g., notebook)	Outpatient rehab. facility	6 mos training program 50-minute daily sessions; reduced to 5 session each week during the last month
Schmitter-Edgecombe et al. (1995)	Comparing notebook training with supportive therapy	8 Divided into two groups (Notebook vs. Support)	Comp. vs. Psych. support	Memory Notebook vs. none	Group 1: Direct training to use memory book; Group 2: supportive therapy	NP	Two 60-min treatment sessions weekly for 8 weeks
Squires et al. (1996)	Effect of using memory aids	1	Comp.	Memory Notebook	Direct training to use memory notebook (Stage I Acquisition, Notebook training; Stage II—Application, generalizing to personal situation)	NP	Stage I: 10 sessions over 16 days; Stage II: 4 wks (wk 1:3 visits; wk 2: 2 visits; wk 3: 2 visits; wk 4:1 visit.)
Van Den Broek et al. (2000)	Effect of using electronic memory aid	5	Comp.	Voice Organizer	Direct training steps to use Voice Organizer.	Home & Clinic	Baseline phase: 3 wks; Training phase: 3 wks; Withdraw voice organizer: 3 wks
Wade & Troy (2001)	Effect of using mobile phones as memory aids	5	Comp.	Mobile phones (4 borrowed phones; 1 used her own.	Demonstration and explanation provided (no explicit training)	Home	NA (trials: 12 weeks with phones)
Wilson et al. (1997)	Effect of using memory aids	15 (20 in initial group, 5 w/drew)	Comp.	NeuroPage: Electronic memory aid	Demonstration provided, no training	NP	NA
Wilson et al. (2000)	Effect of using memory aids	143 completed all stages (198 referrals)	Comp.	NeuroPage: Electronic memory aid	Demonstration provided, no training	Clinic, hospital	7 week Phase I: Group A: pager; Group B: deferred. 7 week Phase II: Group A deferred; Group B: pager.
Wright et al. (2001)	Effect of using external memory aids	12	Comp.	HP & Casio Pocket-computer memory aids	Direct training steps to use the device	NP	During weeks 2 & 3, one visit each week for training. Each machine used for 2 months, with a gap of 1 month between machines
Yasuda et al. (2002)	Effect of using electronic memory aid	8	Comp	Sony IC Recorder	Demonstration provided, no training	Home	Dependent on subject: trials for one week to 3 months
Zencius et al. (1990)	Comparing 3 memory retraining strategies with external memory aids	6 divided into two groups	Retraining vs. comp.	1. Written rehearsal 2. Verbal rehearsal 3. Acronym formation 4. Memory notebook	General instructions to use the notebook; no training specified	NP	NP

Author	**Measurement (Dependent Variables)**	**Generalization**	**Maintenance**	**Who Delivered Tx**
Burke et al. (1994)	1. Functional changes observed every week; 2. Daily journal review by evening staff	To other settings	NP	Family, residential staff, & researchers
Donaghy & Williams (1998)	1. Psychometric measures before and after training; 2. Functional Assessment Measure rating at admission and discharge; 3. 10 functional memory tasks before and after training	(-)	1 Ss	NP
Fluharty & Priddy (1993)	Researchers made sporadic observation of subjects re: effect of using memory book.	NP	NP	Treatment staff
Hart et al. (2002)	1. subject's recall of recorded and unrecorded goals; 2. Interview of subjects and case managers after one-week trials	(-)	(-)	Researcher (2nd author)

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APPENDIX A. *continued*

Kerns & Thomson (1998)	1. Acquisition & Application stages measured via questions and rating system; 2. Adaptation stage measured by daily checklist; 3. Follow-up assessment were undertaken 1 and 2 years after training	(-)	(-)	Counselor & Neuropsychologist
Kim et al. (1999)	Functional gains (arriving therapy on time; compliant with medication) were observed after introducing the palmtop computer	NP	NP	Clinicians & Researchers
Kim et. al. (2000)	Subjects surveyed by phone for follow-up between 2 mos and 4 yrs after training re: utility of palmtop computer for assisting with memory activities	NP	Follow-up at 2mos–4Y	NP
Kirsch et al. (1992)	Scoring system used to judge subject's performance. (Two 60–90 minute weekly trials for 3 months)	(-)	(-)	Researchers
Kirsch et al. (2004a)	% appointments attended	(-)	(-)	SLP or Psychologist
Kirsch et al. (2004b)	#1: Number navigation errors; #2: Average # errors per substep of alarm clock task and total # of subtasks attempted within 5 minutes	NA	#1 = 5 session after w/drawal of device #2: NP	Rehabilitation staff
Ownsworth & McFarland (1999)	# of diary entries made during treatment phase and at the end of the program	(-)	(-)	NP
Quemada et al. (2003)	Subjects assessed at baseline and at end of program using REY, CVLT, & RMBT and 1 memory questionnaire	Across tasks	(-)	Researchers
Schmitter-Edgecombe et al. (1995)	1. Lab-based recall; 2. Lab.-based everyday memory; 3. Retrospective recall of Everyday Memory Failures; 4. Observed Everyday Memory Failures; 5. Symptom Distress	(-)	(-)	Researchers
Squires et al. (1996)	Stage I: paired assoc. recall at a delay of 24 hours, 7days, and 10 weeks; Stage II: questions related to 10 selected diary entries each session	Stage II	(-)	Researcher
Van Den Broek et al. (2000)	Performance on message-passing tasks (12 messages/each phase) and recall of household chores (weekly session)	(-)	(-)	Researchers & relatives
Wade & Troy (2001)	Inspection of individualized diaries & qualitative feedback. Caregiver Diaries: a. self initiated behaviors for 6 wks prior to the treatment; b. during phones use; c. following phone	(-)	maintained use at 12 weeks	NA
Wilson et al. (1997)	Measurement of real life memory failures during Baseline phase (2–6 wks); Treatment phase (12 wks); Posttreatment phase (3wks)	(-)	(-)	NP
Wilson et al. (2000)	Performance on: 1. targeted tasks a. prior to device; b. week 8 or 9; c. week 15 or 16; 2. caregiver strain index	(-)	Grp A	NP
Wright et al. (2001)	At 22 weeks: # of diary entries made in two machines	NP	NP	Researchers
Yasuda et al. (2002	Measurements of: 1. main tasks (diary completion, letter exercise & physical exercise); 2. subtasks (varied for each subject)	(-)	(-)	Researchers & relatives
Zencius et al. (1990)	# of memory assignments completed accurately during baseline and during the four experimental conditions	(-)	(-)	NP

APPENDIX A. Evidence Base Tables. Table III. Methods

Author	Focus	Number	Type of Study	Control	Validity	Stats Analysis
Burke et al. (1994)	Effect of a new approach to memory book training	1	Class III Case Study	NA	NP	NA
Donaghy & Williams (1998)	Effect of memory book training	2	Class III Case Study	NA	NP	NA
Fluharty & Priddy (1993)	Effect of using memory aids	1	Class III Case Study	NA	NP	NA
Hart et al. (2002)	Effect of using electronic memory aid	10	Class II Within-Subject design	Compared recorded & nonrecorded goals	NP	Friedman nonparametric repeated measures analysis of variance by ranks

(-) = None, NP = Not provided, NA = Not applicable, M = Mean

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APPENDIX A. *continued*

Kerns & Thomson (1998)	Effect of using memory aids	1	Class III Case Study	Compared to baseline	NP	NA
Kim et al. (1999)	Effect of using memory aids	1	Class III Case Study	NA	NP	NA
Kim et. al. (2000)	Effect of using memory aids	12	Class III Case Study	NA	NP	NA
Kirsch et al. (1992)	Effect of using electronic memory aid	4 (initially had 7)	Class II Single Subject experiment (ABABA design) 1 Subject: ABA	Replicated B effects	NP	NA
Kirsch et al. (2004a)	Use of alphanumeric paging system to cue use of daily planner	1	Class III Case Study ABA	Compared use of pager with planner alone	NP	NA
Kirsch et al. (2004b)	Evaluate use of Web-based content on iPAQ to guide completion of functional tasks	2	Class III Case Study	Withdrawal of device (ABA) for #1; ABAB alternating design for #2	NP	NA
Ownsworth & McFarland (1999)	Effect of using diary on episodic memory	20 (selected from 30)	Class II Group comparison (DO vs. DSIT)	N = 31 (controlled for memory severity but not diary use)	NP	*t* test, *F* test, and ANOVA
Quemada et al. (2003)	Effect of cognitive retraining strategies and external aids	12	Class II Single Subject experiment	Pre-and posttreatment comparison	NP	Correlation Coefficient.
Schmitter-Edgecombe et al. (1995)	Comparing notebook training with supportive therapy	8 Divided into two groups (Notebook vs. Support)	Class II: group Comparison (Notebook training vs. Supportive therapy)	Control via supportive group	NP	Analysis of covariance

Squires et al. (1996)	Effect of using memory aids	1	Class III Case Study	Compare errorless and errorful training	NP	Mean (SD), *t* test
Van Den Broek et al. (2000)	Effect of using electronic memory aid	5	Class II Single Subject experiment (ABA design)	ABA withdrawal effect	NP	Mean (SD)
Wade & Troy (2001)	Effect of using mobile phones as memory aids	5	Class III Case Study	NA	NP	NA
Wilson et al. (1997)	Effect of using memory aids	15 (20 in initial grp, 5 w/drew)	Class II Single Subject experiment (ABA design)	ABA withdrawal effect	NP	Mean (SD)
Wilson et al. (2000)	Effect of using memory aids	143/198 completed all stages	Class I Randomized control & crossover ABA design	ABA withdrawal effect	NP	Mean (SD),F test, Odds ratio test, Chi-square
Wright et al. (2001)	Effect of using external memory aids	12	Class II Within Subject design. Comparison of 2 computers	Group comparison	NP	*t* test
Yasuda et al. (2002)	Effect of using electronic memory aid	8	Class II Single Subject experiment (ABA design)	ABA withdrawal effect	NP	Descriptive statistics (percent task completion)
Zencius et al. (1990)	Comparing 3 memory retraining strategies with external memory aids	6 divided into two groups	Class II Single Subject experiment	Compare 3 Memory retraining strategies with external	NP	Mean range

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APPENDIX A. Evidence Base Tables. Table IV. Outcomes

Author	Focus	Number	Change in Impairment (None of the Studies Were Impairment Focused)	Change in Activity/ Participation	Author Conclusions	Call for Future Research
Burke et al. (1994)	Effect of a new approach to memory book training	1	NA	Subject became more organized, less overloaded with information, less confused, and generally more receptive to corrective feedback from others	The best memory books are those that suit individual needs and require the least time and energy to maintain. Clinicians who recommend memory books to patients need to consider the physical, cognitive, social, and emotional strengths and weakness of the individual	NP
Donaghy & Williams (1998)	Effect of memory book training	2	No change on psychometric measures	Subject 1: recorded medication w/90–100% accuracy; completed 10/10 functional memory tasks. Subject 2: Due to lack of awareness, training was unsuccessful and journal was d/c	The success of the AHP Memory Journal is because it is individualized, incorporates a needs assessment, and provides instruction based on memory theory. Memory journals are appropriate for a subset of patients who have severe memory impairments (those who want to remember future events and past activities and can read and write)	NP
Fluharty & Priddy (1993)	Effect of using memory aids	1	NA	The subject was independent for most ADL's (preparing meals, shopping, driving, and attending or participating leisure activities)	The use of a memory book was a practical memory aid because it allowed the client to compensate for an impaired memory	NP
Hart et al. (2002)	Effect of using electronic memory aid	10	NA	Recorded goals were recalled better than unrecorded goals after 1-week trials and appeared to be associated with better awareness or follow-through with therapy objectives	Using a voice organizer to listen to recorded goals at multiple, consistent times each day was effective in enhancing recall of goals at the verbal level. In addition, subjects were more conscious of their recorded goals and more likely to follow through with them. Portable electric devices have the potential to assist with treatment areas beyond tasks involving prospective memory	1. Compare the recording intervention to a strategy in common clinical use, such as a written list; 2. Include gradual fading of staff assistance over a longer time than one week to ensure that the device could be used independently or with minimal assistance; 3. Continue investigating the use of other device functions beyond recording and listening therapy goals; 4. Develop methods of teaching people with cognitive impairment to program the devices themselves
Kerns & Thomson (1998)	Effect of using memory aids	1	NA	Parent reported subject became more aware of things around her, and more oriented to things she needed to do after memory notebook training. Teacher survey showed no difficulty with assignments or getting to classes on time	Memory notebook systems can be implemented effectively for children and adolescents with memory impairment in the school setting	NP
Kim et al (1999)	Effect of using memory aids	1	NA	The subject was able to: 1. arrive on time without staff cues; 2. ask for medications on time without staff support	A microcomputer was useful in improving the functional memory behavior of a head injury survivor and in shortening his length of stay	Corroborate the utility of this intervention in acute-subacute rehabilitation settings
Kim et. al (2000)	Effect of using memory aids	12	NA	Three-quarters of the subjects reported computers to be useful on a daily basis during supervised usage trials. Over three-quarters of those subjects continued to use devices after the usage trials had ended	Palmtop computers can be useful as external memory aids to assist patients with impairments in prospective memory function	Explore subjects' success in using palmtop computers in work simulation activates and the cost-effectiveness of these machines. Explore life satisfaction among people using palmtop computers for assisting in the organization of their life
Kirsch et al. (1992)	Effect of using electronic memory aid	4 (from 7)	NA	By using the computer-assisted compensatory cuing system, 2/4 subjects improved performance on a simulated janitorial task	The interactive computer-assisted compensatory cuing system is useful for brain injury patients with memory impairment	NP

continues

APPENDIX A. *continued*

Kirsch et al. (2004a)	Use of alphanumeric paging system to cue use of daily planner	1	NA	With pager, # of planning entries increased and was maintained. Subjects went from an average of 22% attendance to therapy to an average of 93.5% attendance	Structured, time-dependent activity cuing can successfully facilitate prospective task performance. Supports other studies (e.g., Wilson et al., 2000)	Evaluate whether alternative paging schedules (e.g., variable interval) or faded cuing may result in sustained planner use after withdrawal of pager
Kirsch et al. (2004b)	Evaluate use of Web-based content on iPAQ to guide completion of functional tasks	2	NA	#1: Significantly reduced errors when navigating to therapy sessions using device; some maintenance after initial d/c of device #2: Substantially less errors when cued by device; completed all 6 steps of alarm clock task on every trial when using device cueing vs once during uncued trials	Web based content cueing resulted in improved participant performance for tasks that had been prohibitively difficult over extended periods of time prior to device intervention	Investigate whether repeated reintroduction of a cueing device will eventually result in stable acquisition of task performance
Ownsworth & McFarland (1999)	Effect of using diary on episodic memory	20 (Selected from 30)	NA	During treatment phase, the DSIT group maintained use of diary longer but # entries was not different. DIST reported less memory problems, and made more positive ratings	The choice of memory assessment procedures needs to be guided by the subjects' real daily living needs, and a training approach based upon self-instruction is more effective than an approach that focuses on task specific learning	NP
Quemada et al. (2003)	Effect of cognitive retraining strategies and external aids	12	Modest improvement in some CVLT scales; no significant change in the REY and RBMT	9 of the subjects were able to travel around town without supervision with the external aid and specific training (e.g., road awareness)	Neuropsychological tests assessing memory process show a moderate degree of improvement of function after a period of rehabilitation, but they tell us little about the functional gains obtained in rehabilitation through the use of external aids or environmental modifications. Self-report questionnaires tell us more about meta-memory than actual memory function	Research into the effectiveness of memory rehabilitation requires outcome measures that take independence in ADL into account, and measures the improvement mediated by external aids and environmental change

Schmitter-Edgecombe et al. (1995)	Comparing notebook training with supportive therapy	8 Divided into 2 grps (Notebook/ support)	No change in WMS-R for either group	Notebook group reported significantly fewer everyday memory failures on daily checklist than the supportive therapy group	There are potential benefits of combining group support and notebook training therapies. Chronic survivors of severe CHI may demonstrate long-term benefits from training with a memory notebook. Daily observation checklists may be more sensitive measures than laboratory-based tasks for detecting the effects of external memory remediation training.	Explore individual characteristics of those who benefited versus those who did not (e.g., high vs. low IQ); verify usefulness of daily checklist strategy for memory and other cognitive impairments
Squires et al. (1996)	Effect of using memory aids	1	NA	Notebook training was effective in reducing frequency of questions subject asked spouse about daily events	An initially difficult and highly dependent patient can be educated into the use of a notebook. An errorless learning procedure can be used to teach novel associations (Stage I). The use of the notebook was applicable to daily events (Stage II)	Further study of rehabilitation might develop this approach along with other recent strategies adopted for notebook and diary training
Van Den Broek et al. (2000)	Effect of using electronic memory aid	5	NA	All subjects benefited from introduction of aid on the Message-Passing task. All but one improved prospective recall on the Domestic Task measurement	A Voice Organizer may be a useful aid for prospective memory impairments but there was not a significant change in affect associated with its use	NP
Wade & Troy (2001)	Effect of using mobile phones as memory aids	5	NA	All subjects showed mobile phone to be effective in increasing self-initiated behaviors	The mobile phone has considerable potential as a valuable memory aid. The mobile phone is not only of benefit for everyday memory problem, but also assists when individuals have problems with planning and organization. The mobile phone as a memory and organizational prompt has potential to enhance independence and may also have the potential to reduce stress and frustration amongst caregivers	Further trials are needed with more participants. The number of participants in this study does not allow for rigorous statistical analysis

continues

APPENDIX A. *continued*

Wilson et al. (1997)	Effect of using memory aids	15 (20 in initial grp. 5 w/d)	NA	All 15 subjects showed significant improvement in percentage of target tasks completed	NeuroPage is very simple to use and has the potential to enhance independence and employability, speed up hospital discharge, and reduce stress	Evaluate whether lack of maintenance following device withdrawal is due to planning/organization deficits
Wilson et al. (2000)	Effect of using memory aids	143 completed all stages (198 Referrals)	NA	More than 80% of subjects carried out targeted activities (e.g., self-care and keeping appointment) when using pager in comparison with baseline period	NeuroPage significantly reduced everyday failures of memory and planning in people with brain injury at relative low cost. The paging system is particularly useful for people with some insight and sufficient vision to read the screen	NP
Wright et al. (2001)	Effect of using external memory aids	12	NA	All subjects could use memory aids to complete targeted activities; 83% of subjects reported the pocket-computer memory aids were useful	People with memory impairments resulting from brain injury can use purpose-designed computer-based memory aids. Frequent users preferred the computer with a keyboard, whereas infrequent users preferred the smaller, palm-size device	NP
Yasuda et al. (2002)	Effect of using electronic memory aid	8	NA	Output provided by IC Recorder was effective in prompting main tasks for 5/8 patients	Recorders prompted action and compensated for prospective memory impairment; recorders have potential to alleviate caregiver burden & increase independence	Compare the efficacy of spoken versus written messages; evaluate the impact of using participants' own voices vs. caregiver voice
Zencius et al. (1990)	Comparing 3 memory retraining strategies with external memory aids	6 Divided into 2 groups	NA	All subjects benefited from notebook logging condition. The retraining conditions had little impact on the targeted task completion	The notebook logging condition (external memory aid) was the superior memory remediation technique in both groups. Only memory notebook logging was effective in increasing recall of classroom materials	Conduct research with other cognitive retaining strategies, such as computer training programs, and music therapy. Also, research should be performed to see if continued use of external memory aids improves cognitive abilities

APPENDIX B. Survey Articles Summary

	Crowe et al. (2003)	**Evans et al. (2003)**	**Hart et al. (2004)**
Focus	Explore use of automated machines by users with cognitive impairment	Explore ABI patients' usage of external aids.	Obtain data on consumer attitudes to portable electronic devices; examine interest in using these devices
Severity (N)	Control (30); Mild (30); Moderate (30); Severe (30)	NP 94 (from 101)	NP (80)
Mean Age in Years (and range)	Control (45.8); Mild (42.4); Moderate (50.4); Severe (47.0)	39.53 (17–70)	39.1 (17–70)
Male/Female	Control (26/4); Mild (28/2); Moderate (29/1); Severe (25/5)	6 M/30 F	62/18
Race	NP	NP	White: 56; African-American: 22; Others: 2
Mean Education in Years (range)	Control (10.5); Mild (9.8); Moderate (10.1); Severe (10.5)	11.95 (9–19)	12.6
Pre- or Postmorbid Occupation	NP	Subjects were put in occupational categories	Premorbid: 74 worked or attended school Postmorbid: 30 attended school or worked; 44 were unemployed
Postinjury Situation	NP	NP	Majority in private homes; 11 in supervised group homes affiliated w/residential treatment facility
TPO in Years (range)	NP	M: 5.89 (1–26)	M: 3.7
Etiology	ABI (Alcohol-Related Brain Injury): 70; TBI: 16; Hypoxia: 2; Stroke: 1; Tumor: 1	MVA, CVA, falls, epilepsy, encephalitis, assault, explosion, Korsakoff's syndrome, meningitis, tumor	MVA: 59; Fall: 10; Assault/gunshot; 10; unknown; 1
Dual Diagnosis/ Comorbidity	NP	TBI +CVA (n = 2)	NP
Initial Severity	NP	LOC: M: 15.24 (0–280) days	GCS on ER admit for 37 participants M = 8; Median PTA (participant est.): 42days
Neurological Testing	Significant. memory impairment per WMS-R.	Significant memory impairment: RBMT, TEA, VOSPB	NP

Note. (-) = None; NP = Not provided; NA = Not applicable; M = Mean

continues

APPENDIX B. *continued*

Neurological Testing	Significant. memory impairment per WMS-R.	Significant memory impairment: RBMT, TEA, VOSPB	NP
Selection/ Exclusion Cirteria	Exclusion: No psychiatric or developmental disorders, no drug use	Exclusion: Not able to complete the assessment	Selection: TBI from an external source with documented loss or alteration of consciousness for ≥24 hours and/or the presence of a traumatic abnormality on neuroimaging studies. Medical records review at a minimum of 3 months postinjury. Exclusion: Premorbid conditions that might affect cognitive function
Type of Aid	No aids were provided (Automated machines, e.g., ATM, automatic telephone, automatic ticketing machine)	Variety of aids	Portable electronic devices
Treatment Setting	Rehab office & Community	NA	Post-acute TBI rehabilitation programs
Measurement	Pre- and posttask self-reports plus objective measurements. (Phase I: Survey; Phase II: Perform automated machine tasks)	Compensatory aid/strategy checklist completed during interview	Quantitative and Qualitative analysis of survey results via structured interview
Type of Study	Group comparison (ABI and control groups)	Survey	
Control	N: 30	NA	NA
Statistical Analysis	Chi-square	Chi-square; *t*-test	Chi-square, nonparametric statistical comparisons (e.g., Mann-Whitney U test)
Outcomes	Subjects had difficulty understanding and remembering the instructions on automated machines	External aids such as calendars, wall charts, and notebook were the most commonly used memory aids	Two-thirds of participants reported regular use of computers, but less than one-third had experience with handheld computers or similar devices. Interest in using portable devices for everyday memory and organizational tasks was higher than the expressed need for improvement in participants' current strategies. Preferred functions included keeping track of money spent, remembering things to do, and remembering what other people say

continues

APPENDIX B. *continued*

	Crowe et al. (2003)	**Evans et al. (2003)**	**Hart et al. (2004)**
Author Conclusions	Use of automated machines decreased with severity of impairment. Self-awareness decreased with severity of impairment	Electronic organizers were not used by many subjects. Variables that best predicted use: age, TPO, number of aids used premorbidly, performance on attentional functioning	Portable electronic devices are accepted and desirable as memory and organizational aids by persons with significant disability due to TBI
Call for Future Research	Correlating performance on these practical tasks with neuropsychological tests to determine whether standardized tasks have a capacity to predict automated machine competency	Explore alternative measure, e.g., relative or therapist rating the global effectiveness of memory-aid usage	Explore the direct experiences and preferences of the strategy user to match the best strategy to each user in clinical practice and to help expand the clinical armamentarium

APPENDIX C. Glossary of Terms

BADS	Behavioral Assessment of the Dysexecutive Syndrome
CD	communication disorders
CVA	cerebral vascular accident
CVLT	California Verbal Learning Test
CVLT II	California Verbal Learning Test II
DAI	diffuse axonal injury
DFRT	Donmon Face Recognition Test
DRS	Dementia Rating Scale
EMQ	Everyday Memory Questionnaire
EOWPVT	Expressive One Word Vocabulary Test
FSIQ	Full scale intelligence quotient
GCS	Glasgow Coma Scale
MFE	Memory Failure in Everyday Life Questionnaire
MVA	motor vehicle accident
NART	National Adult Reading Test
PANAS	Positive and Negative Affect Scale
PIQ	Performance intelligence quotient
PPVT	Peabody Picture Vocabulary Test
PTA	posttraumatic amnesia
RBMT	Rivermead Behavioral Memory Test
REY	Rey Auditory Verbal Learning Test
SAH	subarachnoid hematoma
SCOLP	Speed and Capacity of Language Processing
SDH	subdural hematoma
TBI	traumatic brain injury
TEA	Test of Everyday Attention
TPO	time postonset (of injury)
TRLSAB	Trailmaking: A & B
VIQ	Verbal intelligence quotient
VOSPB	Visual Object and Space Perception Battery
WAIS–R	Wechsler Adult Intelligence Scale–Revised
WAIS–III	Wechsler Adult Intelligence Scale–III
WCST	Wisconsin Card Sorting Test
WISC	Wechsler Intelligence Scale for Children
WMS	Wechsler Memory Scale
WMS–R	Wechsler Memory Scale–Revised
WRAM	Wide Range Assessment of Memory and Learning
WRAT–R	Wide Range Acheivement Test–Revised
WRMT	Warrington Recognition Memory Test

APPENDIX D. External Memory Aid Devices

Devices	**Manufacturers**
Casio Pocket computer	Casio Computer Co. (www.casio.com)
HP Pocket computer	Hewlett-Packard
IPAQ	Hewlett-Packard (Compaq/www.compaq.com)
NeuroPage	Neuropage (www.neuropage.nhs.uk)
NotebookG	Generic/multiple manufacturers (e.g., ThinkVantage Technologies)
Palmtop computer	Generic/multiple manufacturers (e.g., Hewlett-Packard)
Parrot Voice Mate III	Parrot Software Co. (www.voice-assistant.com)
PSION series 3a	Psion Teklogix (www.psionteklogix.com)
Sony IC Recorder	Sony