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# Evidence-Based Practice for the Use of Internal Strategies as a Memory Compensation Technique After Brain Injury: A Systematic Review

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**Objective:** To complete a systematic review of internal memory strategy use with people who have brain injury and provide practitioners with information that will impact their clinical work. **Methods:** A systematic literature search to identify published intervention studies that evaluated an internal memory strategy or technique to improve memory function of individuals with brain injury. Relevant data from reviewed articles were coded using 4 clinical questions targeting participants, interventions, research methods, and outcomes. **Results:** A comprehensive search identified 130 study citations and abstracts. Forty-six met inclusion/exclusion criteria and were systematically reviewed. Visual imagery was most frequently studied, in isolation or in combination with other internal strategies. Despite significant variability in research methods and outcomes across studies, the evidence provides impetus for use of internal memory strategies with individuals following brain injury. **Conclusions:** Individuals with traumatic brain injury may benefit from internal memory strategy use, and clinicians should consider internal memory strategy instruction as part of intervention plans. Further research needs to better delineate influences on intervention candidacy and outcomes. **Key words:** *brain injury*, *evidence-based practice*, *memory*, *rehabilitation*, *systematic review*

THIS ARTICLE is another in 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 ANCDS EBP project was initiated over a decade ago, with the creation of expert committees charged with reviewing the literature to develop evidence-based clinical practice guidelines for a range of neurogenic communication disorders.[1,2] This article provides practice recommendations for the use of internal memory strategies and was generated by members of the ANCDS EBP subcommittee on cognitive-communication disorders associated with traumatic brain injury (TBI). It is a complement to 1 on the use of external aids as a memory compensation technique.[3]

Multiple systematic reviews and meta-analyses of memory strategy use post-TBI have been published. Some of these analyses are embedded in reviews of comprehensive cognitive rehabilitation therapy.[4–12] A recent meta-analysis[13] and a recent systematic review[14] analyzed studies specific to memory rehabilitation, but both examined impairment-based or restorative therapies rather than strategy training interventions and, thus, were not relevant to the current review. A third recent review by an international group (INCOG) also focused on the memory rehabilitation literature but had a broader inclusion and reviewed studies evaluating the use of internal and external memory strategies as well as restorative techniques to develop clinical practice guidelines for memory intervention.[12] They concluded that the integration of internal and external memory

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strategies taught individually or in groups can be useful to individuals with mild to moderate memory impairments and found weak evidence regarding restorative memory techniques.

Two frequently cited reviews were published by the Institute of Medicine (IOM)[10] and Cicerone and colleagues.[7] The IOM[10] reported on 14 studies that featured internal memory strategies. To be included in their review, studies had to include a majority (50% or more) of participants with TBI and had to be published after 1991. Results revealed that the majority of the studies targeted participants with moderate-severe TBI. They concluded that there were immediate treatment benefits to those who used various internal memory strategies, characterized by improvement on standardized memory tests. However, there was limited evidence that internal memory strategies made positive functional changes that were also maintained over time.

In their 2005 review, Cicerone and colleagues[7] reviewed treatment studies published between 1998 and 2002 in cognitive rehabilitation that included memory and the use of internal (eg, visual imagery and rehearsal) and external (eg, planners and alarms) strategies. Criteria for review included clinical studies conducted with participants diagnosed with TBI or stroke. Of the 13 studies evaluating remediation of memory deficits, 1 targeted internal memory strategies, and it was a prospective, randomized controlled trial that investigated the effectiveness of visual imagery training postacquired brain injury.[15] On the basis of their 2000 and 2005 reviews, internal and external strategy training was classified as a practice standard for individuals with mild memory impairment. For individuals with moderate or severe memory impairment, the authors recommended external strategy training as a practice guideline. The 2011 review by this group did not include studies of internal memory strategies.[8]

Why then, this review? First, not all systematic reviews are created equal. Report characteristics vary across reviews and analyses, as do target stakeholder audiences, and so conclusions regarding evidence may vary.[16,17] For example, a systematic review to inform the design of a research study would be different from a systematic review to inform a clinical decision to use 1 therapeutic technique versus another. Although research design determines the level of trustworthiness of the clinical conclusions, there can be important clinical lessons in articles with less rigorous methodology. A primary purpose of this article was to provide practitioners with clinically relevant information about the use of internal memory strategies following TBI reported in the research literature. Although the recent INCOG review[12] did focus on practice intervention, its purpose was to provide broad practice guidelines for all memory interventions. We aimed at organizing and distilling the evidence in a way that will guide clinician implementation specifically for internal memory strategies.

Internal memory strategies are behaviors or techniques designed to help a person gain control over his or her learning and recall ability. Also known as mnemonic strategies, they involve mental manipulations to facilitate memory of targeted stimuli. They may be task specific and used to learn an explicit body of information such as forming an acronym to remember a medication regimen, or they may be generalized strategies designed to enhance memory across information domains such as the use of visual imagery for remembering.[18] Internal memory strategies are carried out "internally" or covertly as one thinks in a new or different way to encode material. The use of internal memory strategies may be effective because they (1) encourage a deeper level of processing, which improves recall; (2) can facilitate integration of isolated information; and/or (3) provide built-in retrieval cues.[19]

The literature exploring the use of internal memory strategies has a long history. Internal memory papers span over 3 decades with more publications in the earlier years, as this memory intervention approach was used more commonly in the past.[11] More than one-third of the studies analyzed for this review were published at least 2 decades ago. Although these early studies hold important lessons, the research methodology is not up to current standards, making it difficult to analyze their intervention efficacy.

More recent studies include several well-controlled trials[15,20] evaluating and supporting the use of internal memory strategies. Yet, this approach has not been a primary focus in the cognitive rehabilitation literature since the 1990s. Kaschel and colleagues[15] suggest several reasons why researchers and clinicians may be reticent to employ internal memory strategies–(1) they may be too complex for people with cognitive impairments; (2) they may be unnatural and difficult to apply to everyday life activities; and (3) their generalized use has not been well documented in people with memory and executive function impairments. The pervasive and devastating effects of memory impairments encourage investigation of all interventions with potential to mitigate the impact of memory deficits. This review attempts to integrate and analyze the available evidence within the context of challenges to their clinical implementation.

## METHODS

### Searching, gathering, and selecting studies

The literature search was conducted to identify published intervention studies that evaluated an internal memory strategy or technique whose purpose was to improve the memory functioning of individuals with brain injury. As in previous ANCDS systematic

reviews of cognitive rehabilitation,[3,9,21,22] the following inclusion and exclusion criteria were used to select studies for this review:

1. Studies that had participants with the diagnosis of TBI were included; studies that included other diagnostic groups were acceptable as long as individuals with TBI were included.
2. Peer reviewed, empirical studies were included; chapters, books, dissertations, theoretical articles or studies, and reports without data were excluded.
3. Study designs were considered for inclusion as long as identifiable baselines and posttreatment outcomes were reported.
4. Studies that investigated effects of using internal memory strategies were included. Studies that investigated the use of compensatory external memory aids only were excluded.[3,8]
5. Within-subject design studies in which participants were presented with alternative methods of encoding in a single trial were excluded because they were not intended as interventions.

Ten databases were searched through March 2015—MEDLINE, PsychInfo, PsychArticles, the Cumulative Index to Nursing and Allied Health Literature (CINAHL), ERIC PubMed, CSA Linguistics and Language Behavior Abstracts, Health Source: Nursing, ISI (which includes Social Science Citation Index and Medline), ScienceDirect, and REHABDATA. Reference lists from prior published reviews were also examined and compared with the studies identified by searching databases. Prior reviews were also identified to make sure that no studies were missed, including the systematic reviews by Cicerone and colleagues,[6–8] the Cochrane Database of Systematic Reviews,[23] and the cognitive rehabilitation review by the IOM.[10]

The initial search was performed using combinations of the following keywords: *traumatic brain injury or brain injury or closed head injury or acquired brain injury* for the population; *memory* for the type of deficit; and *intervention or treatment or therapy or training or remediation*, or *rehabilitation* or *imagery or elaboration or encoding or rehearsal for therapy*.

Figure 1 displays the process to search, gather, identify, and select published, peer-reviewed intervention studies. This resulted in more than 2900 citations with abstracts. First, the second author conducted the search and reviewed citations and abstracts. The vast majority were excluded because they were pharmacological studies, were not peer reviewed, were not in English, or did not include a memory intervention. Next, each author independently read 130 abstracts, at which point another 54 were excluded for the same reasons. Thus, 76 studies were read in entirety and reviewed by the authors. There was 100% consensus to exclude an additional 30 studies for reasons listed on Figure 1, which brought the final number of included studies to 46.[15,21,24–67]

## Reviewing and extracting data

Four clinical questions were used as a schema to code the relevant data extracted from each article.[3,9,10,21,22] Table 1 lists these questions with the corresponding extracted data. The questions organized the data into the following 3 tables of evidence (TOE): (1) participant characteristics, (2) study design and intervention characteristics, and (3) study outcomes. These 3 tables are available at: http://links.lww.com/JHTR/A146; http://links.lww.com/JHTR/A147; and http://links.lww.com/JHTR/A148. The Participant TOE includes participant data from each study (eg, *N*, average age, years of education, and diagnosis). The Design and Intervention TOE includes study design, level of evidence, purpose of study, description of the intervention, research stage, and methodological quality indicators. The Outcomes TOE includes intervention outcomes and quality indicators related to outcomes.

We defined and coded each study's level of evidence using The American Academy of Neurology's (AAN) classifications I through IV.[68,69] Table 2 provides descriptions of these, with their corresponding requirements and clinical recommendations. All types of designs were considered, including randomized control trials (RCTs) with or without assessor blinding, other group designs, and case reports. Because single-subject, multiple baseline studies are not included in the AAN's classification scheme, they were coded as class II evidence, consistent with prior reviews by ANCDS.[3,21]

Each study was evaluated for its research stage using the AAN[68] schema as follows: "discovery" in which a treatment is assessed to show promise of efficacy; "efficacy" in which treatment is tested in an ideal and highly controlled condition/context; "effectiveness' in which treatment is tested in the "real world" and under routine conditions; and "cost benefit/public policy" in which the economic and societal benefits of the effective treatment are assessed. "Efficiency" studies are typically based on effective treatments to determine whether changes in dosage or timing result in changed outcomes. Methodological quality indicators were used to evaluate each study as present (1) or absent (0). Some indicators were applicable for group studies only—presence of a published intervention manual or protocol, assessor blinding, sampling methods description, comparability of groups or participants, and treatment fidelity.

The Outcomes TOE includes intervention outcomes and quality indicators related to outcomes, which were classified as *decontextualized* or *person centered*. Decontextualized outcomes are measurements traditionally

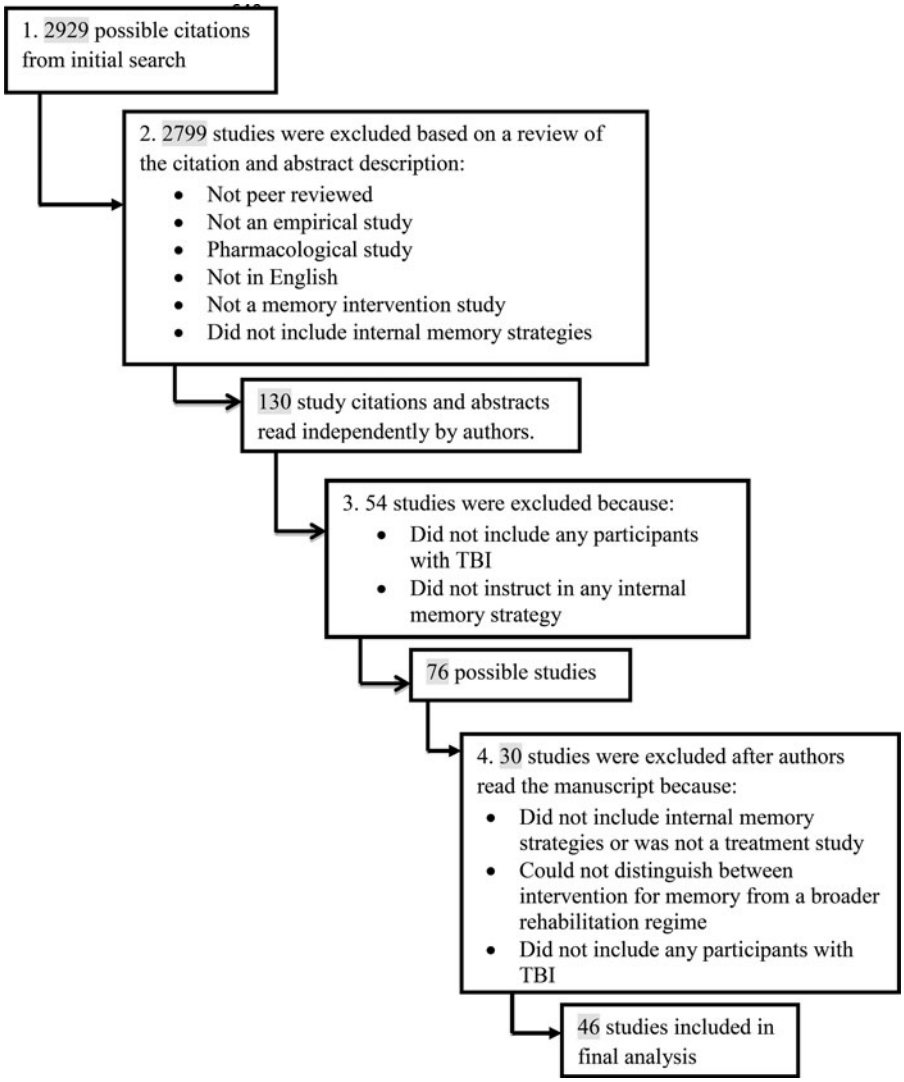


**Figure 1.** Diagram of steps used to gather, identify, and select studies included in this review.

**TABLE 1** *Systematic "clinical" review questions, extracted data, and table of evidence*

| Questions | Extracted data | Table of evidence |
|---|---|---|
| Who were the participants who received the intervention? | Number, age, education, sex, diagnosis, time postonset, etiology, severity of injury and evidence, severity of impairment, comorbidities, treatment history, criteria | Participant |
| What comprised the research methodology? | Study design and purpose, level of evidence, stage, assessor blinding, sampling, participant comparability, treatment fidelity | Intervention |
| What comprised the internal memory strategies? | Strategies taught, theoretical rationale, treatment description/task, schedule, duration, therapy manual/detailed description | Intervention |
| What were the targets and outcomes? | Immediate and follow-up decontextualized, and person-centered outcomes, significance, effect sizes, precision, intent-to-treat | Outcomes |

**TABLE 2** *Levels of evidence, requirements, and recommendations with descriptive language from the American Academy of Neurology (2011)*

| Level of evidence | Requirements | Recommendation |
|---|---|---|
| Class 1: RCT with masked outcome assessment in a representative population with qualifiers | At least 2 RCTs that demonstrate effectiveness and usefulness | Practice Standard " It must be done" |
| Class II: prospective matched group cohort studies in a representative population with masked outcome assessment that meets class I evidence but lacks 1 or more criteria | At least 1 class I RCT or 2 consistent class II studies probably effective for a given condition in the specified population | Practice Guideline " It should be done" |
| Class III evidence: controlled studies including natural history control or patients serving as their own control; outcomes are treatment independent | At least 1 class II or 2 class III studies, which determine that treatment is possibly effective | Practice Option " It may be done" |
| Class IV evidence: uncontrolled studies, case series, case reports, or expert opinion | Data are inadequate or conflicting; current knowledge, treatment is unproven | No recommendation |

Abbreviations: AAN, American Academy of Neurology; RCT, randomized controlled trial.
Revised from Kennedy MRT.[69]

identified as "impairment measures" based on the World Health Organization International Classification Framework.[70] These are measures of underlying cognitive and/or memory functioning and do *not* capture a behavior, skill, or knowledge *directly* applicable to participants' daily memory functioning. Examples of decontextualized measures include formal assessments of cognitive or psychological functioning using tests not relevant to memory outside of an environmental context or activity and measurement of performance on tasks where the stimuli are not items needed to be remembered for daily functioning. Person-centered outcomes are those that are functionally relevant to the individual; they are direct or indirect measures of activity or participation (from the World Health Organization International Classification Framework)[71] relevant to the participant's actual daily functioning. Examples include changes in functional activities such as remembering names of people in their actual daily life or self-/other reports using questionnaires inquiring about daily memory performance. Timing was identified for each type of outcome; that is, outcomes were described as being *immediate* after the withdrawal of intervention and after time had lapsed since the withdrawal of intervention, that is, *maintenance*. The presence of generalization to other untrained stimuli, activities, or tests was noted as well.

Because researchers typically report various outcome measures, we created a scoring system that accounts for the variety. These outcome "scores" ranged from 0 to 3 (0 = no measure reported, 1 = no significant intervention effect on outcome measure(s), 2 = significant intervention effect on some but not all measures [< 50%], including primary or secondary measures, and 3 = significant intervention effect on most or all intended measures [≥ 50%]).

Finally, outcome quality indicators were identified and coded as present (1) or not present (0). These included statistical significance; intervention effect sizes; precision of intervention reported in confidence interval; outcome measures; and statistics that account for participant attrition, that is, intent-to-treat.

### Reliability

Each author independently reviewed a subset of the 46 selected studies and extracted data onto TOE, as "the" primary reviewer. A second reviewer (1 of the authors) who was blinded to the primary reviewer's data extraction reviewed 16% or 35% of the studies. The interrater reliability agreement was 95.2% for participant data, 92.8% for design and intervention data, and 97.7% for outcomes data. Overall, the interrater agreement was 95.23%.

## RESULTS

The 3 TOE were created to display extracted data from the 44 studies (available at: http://links.lww.com/JHTR/A146; http://links.lww.com/JHTR/A147; and http://links.lww.com/JHTR/A148). For ease in synthesizing data, studies were listed by their AAN classification of evidence, that is, I, II, III, IV,[68] and then alphabetized. A narrative summary of the results answering each of the 4 clinical questions guiding this systematic review follows.

**Question 1: who were the participants?**

A total of 1 143 participants were included in the studies under review. Table 3 provides a summary of participant information, and the TOE: Participants (available at: http://links.lww.com/JHTR/A146) provides details of each study. The number of participants per study varied from 1 to 332, with the majority of studies (65%) having 20 or less, and 24% having 3 or less. Note that an inclusion criterion for this review was that a study had to have at least 1 participant with TBI or closed head injury. Up to 84% of participants across studies had sustained a TBI. Other diagnoses included stroke, anoxic brain injury, and brain tumor. Nearly all studies reported time postinjury onset, although with varied specificity (eg, > 6 months; group mean; years and months per participant). Participants in just over half of the studies were greater than 1 year postinjury. Twenty-five studies (54%) had study-specific inclusion/exclusion criteria.

Sex information was provided in 32 of the 46 studies, with 69% of reported participants being male. Nearly all studies reported age at time of study participation, which ranged from 8.1 to 86.0 years of age. A majority of studies reported educational levels.

**TABLE 3** *Summary of participant demographics across 46 studies*

| Types of participants | Numbers of participants |
|---|---|
| Total number of participants | 1 143 |
| Number of TBI participants | 964 |
| Number of participant with other known diagnoses | 152 |
| Number of participants with unknown diagnoses | 27 |
| Time post injury onset (TPO) | Number (%) |
| Studies that reported TPO | 44 (96) |
| Studies in which participants were > 1 y TPO | 25 (54) |
| Sex, age, and education | |
| Studies that reported sex, males were the majority | 32 (70) |
| Studies that reported age, ranged from 8.1 to 86.0 y | 44 (96) |
| Studies that reported years of education | 32 (70) |
| Studies in which participants had 10-15 y of education | 20 of 32 (62) |
| Severity of injury and impairment | |
| Severity of injury | 27 (59) |
| Severity of impairment | 25 (54) |
| Studies that used traditional labels (mild, moderate, severe) | 21 of 25 (84) |
| Treatment history | |
| Studies that reported on treatment status | 8 (17) |

Just over half of the studies reported injury severity. Thirteen of the 27 studies (48%) used traditional labels of "mild," "moderate," and "severe" injury severity. One study characterized participants as having mild-moderate injury severity; 4 studies characterized participants as having severe injuries; and 7 studies included all severity levels to characterize injuries.

Impairment severity was reported in 25 of the studies. To assess cognition in general, or memory in particular, many of these studies used standardized tests (eg, California Verbal Learning Test,[70]), rating scales (eg, Dementia Rating Scale[72]), and questionnaires (eg, Everyday Memory Questionnaire[73]). Twenty-one of the studies used "mild," "moderate," and "severe" impairment labels, with participants in 4 of these studies (19%) being described as presenting with mild impairments, in 5 of these studies (24%) as presenting with mild-moderate impairments, in 6 studies (28.5%) as presenting with severe impairments, and in 6 (28.5%) as presenting with a range of impairments. Despite the use of these severity labels by 21 studies, only 3 of them[15,20,31] reported using normative data to determine how standardized test scores converted to impairment severity.

Five studies reported that participants had received previous or simultaneous memory-related treatment, and 3 reported that participants did not. Thus, 89% did not report treatment history.

In summary, studies were appraised for 12 participant characteristics. The range of documented characteristics was between 1 and 11 (mean = 7.74; standard deviation = 1.97). Participant characteristics reported in most studies included the number of participants, age, diagnosis, time postonset, and injury severity. Characteristics reported in the least number of studies included comorbidities, therapy history, etiology of injury, and education. Studies reported some participant characteristics differently, and this variability prevented identification of clear participant-related trends.

**Question 2: what comprised the intervention?**

To synthesize the interventions, internal memory strategies had to be identified first. One author reviewed strategy descriptions and sorted the studies into the following 8 categories: (1) Unspecified Internal Memory Strategies; (2) Imagery/Unspecified Computer Program; (3) Imagery Story/Method of Loci; (4) Metacognitive Reading Strategy PQRST; (5) Verbal Elaboration/Semantic Association; (6) Rehearsal; (7) Combined Visual Imagery and Rehearsal/Association; and (8) Combined Verbal/Written Rehearsal and Elaboration or Altered Format. To establish validity of the categories and reliability of strategy assignment, each of the other 2 authors reviewed half of the studies and placed them in the identified categories.

Up to 95% interrater agreement was achieved initially; differences between coders on 2 studies were discussed and resolved to reach 100% agreement.

Table 4 lists the strategies and the number of studies that used them. See the Design and Intervention TOE available at: http://links.lww.com/JHTR/A147 for details of each study. The most frequently evaluated *specific* strategy was visual imagery. Fourteen studies evaluated efficacy of improving memory for targeted information using visual imagery by creating story, location, or concept images with and without computer delivery. Twenty-two studies evaluated different combinations of strategies, representing the largest group of strategies. Of these combined strategies, those that added imagery to a type of association or rehearsal strategy (eg, chaining) accounted for the largest strategy group. Thus, imagery was involved in 32 (69%) of the 46 studies.

A key characteristic of strategy intervention involves identifying how participants are introduced to and taught individual strategies. A review of the studies suggested the following 4 categories of instruction: (1) *systematic instruction* in which the authors used explicit teaching procedures designed to teach strategy use such as errorless learning; (2) *verbal instruction*, which included a script or verbal description of what was said to the participant regarding strategy implementation; (3) *practice* in which the authors indicated there was opportunity to practice the strategy on nontest stimuli; and (4) *unspecified instruction* in which there was no indication of strategy instruction. The largest category was *unspecified instruction* found in 30 (65%) of the 46 studies. Eight studies employed systematic instruction to explicitly teach the strategies; 3 employed verbal instruction, and 5 employed practice.

Some of the studies that were coded as having *unspecified instruction* were delivered in ways that would not require instruction because the strategy was embedded in the nature of the task. For example, organizing a word list to be remembered using a taxonomic category clustering[42] or providing the paired associate for a learning task[31,41] does not require internally generated strategy use by the learner and instead depends on the researcher to deliver the strategy.

The intensity (ie, dosage) of interventions varied widely and depended on the rationale for the study. Studies that compared specific types of strategies using list learning paradigms tended to have few evaluation sessions, whereas those studies that were evaluating a memory intervention program conducted more sessions over a longer duration. Study duration ranged from 11 months to 1 week. The mode duration for studies evaluating a memory strategy training intervention was 6 weeks with 1 to 3 sessions per week. For these treatment studies, the type of intervention was split equally between therapies using memory groups and 1-on-1 interventions. Of the 1-on-1 interventions, 4 studies evaluated computer packages.

In summary, the most commonly evaluated strategy is visual imagery. The majority of the literature base did not describe replicable instructional procedures indicating how to introduce strategies that participants would need to independently implement them to be functional.

**TABLE 4** *Summary of intervention and instruction techniques across 46 studies*

| Types of strategies | Number of studies (%) |
|---|---|
| Visual imagery | 14 (30) |
| Visual imagery story/method of loci | 8 (18) |
| Visual imagery using unspecified computer program | 6 (13) |
| Combined approaches | 22 (48) |
| Visual imagery + rehearsal/association | 18 (39) |
| Verbal/written rehearsal and elaboration or altered format | 4 (9) |
| Rehearsal | 3 (7) |
| Unspecified internal memory strategies | 3 (7) |
| Verbal elaboration/semantic association | 2 (5) |
| Metacognitive Reading Strategy (PQRST) | 2 (5) |
| Instruction categories | |
| Systematic instruction | 8 (17) |
| Practice | 5 (10) |
| Verbal instruction | 3 (7) |
| Unspecified instruction | 30 (65) |

### Question 3: what comprised the research methodology?

The strength of a body of evidence is determined by examining the design and methodology of each study. Features summarized here include study design and level of evidence, research stage, and quality indicators (eg, fidelity and blinded assessors). Table 5 provides this information across the 46 studies. Details of each study can be found on the Design and Intervention TOE (see Supplemental Digital Content, available at: http://links.lww.com/JHTR/A147).

No studies were classified as level I RCTs that met all quality indicators. Of the 20 level II studies, 9 were RCTs. The 4 most commonly omitted quality indicators were assessor blinding, fidelity measurement, effect size, and intent to treat statistics. Eight of the level II studies were "other group designs," and 3 were

**TABLE 5** *Summary of study design/level of evidence and research stage used across 46 studies*

| Level of evidence | Number (%) |
|---|---|
| Level I | 0 |
| Level II | 20 of 46 (43) |
| Discovery | 5 of 20 (25) |
| Efficacy | 12 of 20 (60) |
| Effectiveness | 2 of 20 (10) |
| Efficiency | 1 of 20 (5) |
| Level III | 15 of 46 (33) |
| Discovery | 9 of 15 (60) |
| Efficacy | 6 of 15 (40) |
| Effectiveness | 0 |
| Efficiency | 0 |
| Level IV | 11 of 46 (24) |
| Discovery | 10 of 11 (91) |
| Efficacy | 1 of 11 (9) |
| Effectiveness | 0 |
| Efficiency | 0 |

single-subject, multiple baseline studies. The 17 level II group design studies reported between 0 and 4 quality indicators. Most of these were efficacy studies, followed by studies of discovery, studies of effectiveness, and 1 study of efficiency.

Of the 15 level III studies, 9 were discovery studies, and 6 were efficacy studies. Quality indicators varied depending on the design. Four level III studies did not report any quality indicators, whereas the remaining 11 studies reported between 1 and 4 indicators.

The 11 level IV studies were single case reports or case series. With the exception of 1, all were discovery studies. Four of these 11 studies did not report any quality indicators, whereas the other 7 reported 1 or 2 indicators.

In summary, many of the studies lacked intervention detail, yet, according to the AAN's 2011[68] methodology and indicators, the collective evidence base would be sufficient to generate a Practice Guideline for the use of internal memory strategies if the outcomes are positive.

### Question 4: what comprised the types of outcome measures used and what did they demonstrate?

#### *Types of intervention outcomes*

Forty-one of the 46 studies (85%) investigated decontextualized outcomes; 19 studies (41%) investigated person-centered outcomes; and 15 studies (33%) investigated both types of intervention outcomes (see the Outcomes TOE available at: http://links.lww.com/JHTR/A148). All 46 studies (100%) reported immediate intervention outcomes, and nearly half (48%) reported delayed intervention outcomes. Table 6 summarizes the breakdown of intervention outcome types across the 46 studies.

#### *Intervention outcomes and findings*

Most of the studies that investigated intervention impact on immediate decontextualized outcomes used multiple measures. Standardized tests, especially ones assessing memory, were frequently used, including the California Verbal Learning Test,[70] the Rivermead Behavioural Memory Test,[74] and the Wechsler Memory Scales.[75] Additional "control" measures were standardized tests of attention, reading comprehension, and verbal fluency. Some studies used psychological tests to measure anxiety and depression outcomes. Other types of decontextualized outcome measures included performance on intervention tasks, such as the number of stimuli recalled, the number of trials to reach criterion, the number of cues provided, strategies used, the number of strategies used, knowledge about memory quiz scores, and demographic and injury-related outcome predictors.

Thirty-seven of the 41 studies (90%) that investigated immediate decontextualized outcomes reported some degree of postintervention improvement or positive difference/change on at least 1 outcome measure. Six of the 17 studies (35%) investigating delayed decontextualized outcomes reported some delayed postintervention improvement or positive difference/change on at least 1 measure. Seven of these studies (41%) reported that at least some immediate decontextualized intervention improvements or positive differences/changes were maintained. Four studies (24%) reported that at least some immediate decontextualized improvements or positive differences/changes were not maintained.

Most of the studies that investigated intervention impact on immediate person-centered outcomes used multiple measures. Many of these measures were

**TABLE 6** *Summary of outcomes organized by timing (immediate, delayed) and type (decontextualized, person-centered) across 46 studies*

| Outcomes | Number of studies (%) |
|---|---|
| Immediate outcomes | 46 (100) |
| Decontextualized | 41 (89) |
| Person-centered | 17 (37) |
| Both | 12 (26) |
| Delayed outcomes | 22 (48) |
| Decontextualized | 17 (37) |
| Person-centered | 8 (17) |
| Both | 3 (7) |

nonstandardized tools used for specific, functional purposes. Some standardized outcome measurement tools were used, including the Memory Compensation Questionnaire,[75] the Prospective-Retrospective Memory Questionnaire,[76] the Satisfaction With Life Scale,[77] and the Subjective Memory Questionnaire.[78]

All 17 of the studies (100%) that investigated immediate person-centered outcomes reported some degree of postintervention improvement or positive difference/change on at least 1 outcome measure. Of the 8 studies that investigated intervention impact on delayed person-centered outcomes, 7 of them (88%) reported some delayed postintervention improvement or positive difference/change in at least 1 measure.

In summary, the outcomes reported in the literature suggested that persons with memory impairments following brain injury benefit from internal memory strategy training. However, the majority of the evidence-base investigated decontextualized outcomes of interventions, and a minority investigated person-centered outcomes. Of those that did investigate functionally relevant outcomes, 100% reported participant improvement. All of the studies investigated immediate intervention outcomes, and only half investigated delayed intervention outcomes. With the emphasis of rehabilitation on maximizing person-centered, functional outcomes and quality of life,[70] establishing the reliability and validity of current and/or developing new patient centered outcomes needs to be a priority. Increased number of studies of internal memory strategies is needed to investigate both their immediate and long-term impacts on decontextualized AND functional outcomes and to identify the most efficacious intervention approaches to achieve and maintain positive outcomes of both kinds.

It is important to consider outcomes with respect to the quality of research methods. Experimental rigor of studies has improved over time. This review used a strict criteria of 10 quality indicators. Four RCTs[15,20,40,45] were missing 3 to 5 of the 10 quality indicators; thus, the evidence base is close to being sufficient to generate a Practice Standard.

## CONCLUSION

The evidence base provides encouragement for clinicians and researchers to explore use of internal memory strategies with persons with brain injury. However, a number of limitations make clinical interpretation of the evidence base challenging; hence, clinicians need to carefully collect patient-specific outcome data to evaluate treatment response that can guide ongoing therapy decisions. The significant variability in participant characteristics makes it difficult to identify relevant candidacy factors for matching internal memory strategies to particular patient profiles. For example, the authors held a hypothesis that internal memory strategies would be most useful for participants with mild memory impairment, which was a finding in the INCOG review.[12] Yet, this review showed no clear indication that only those with mild memory impairment benefit from these strategies, and participant profiles were not sufficiently defined to test this hypothesis across studies. However, it was reassuring that the vast majority of research participants were indeed individuals who had sustained traumatic injuries.

Although the scientific rigor of studies has improved over time, this review suggests several methodological issues that should be addressed in future studies. As noted, participant profiles need to be better defined and compared. Experimental designs need to include assessor blinding and treatment fidelity measures, in addition to effect size and intent-to-treat statistics. It is concerning that the majority of the literature base does not offer replicable instructional procedures to teach strategies that would optimize participants' independence and generalize to their daily lives. In addition, it is critical that both decontextualized and person-centered outcome measures are used to evaluate the impact of strategy training.

Overall, the literature base, which spans decades, supports the efficacy of internal memory strategy training. Perhaps, the most clear and clinically relevant trend in the literature was that all of the studies that used systematic instruction and incorporated practice in using strategies reported positive outcomes. When participants with brain injury are taught methods designed to elaborate stimuli to be remembered or deepen the processing while learning information, it increases the likelihood they will be able to recall the information. Given the uniformity of positive reports including findings from 9 RCTs, strategy instruction should be part of a clinician's treatment repertoire. The strongest evidence is in support of visual imagery training; however, visual imagery was also the most commonly evaluated internal memory strategy. Of note to clinicians is that both group and individual instruction were found to be efficacious. Although positive effects of strategy training are reported across different strategy types and participant profiles, it is difficult to directly compare studies given the divergent outcome measures and implementation procedures. Further research investigating the impact of internal memory strategy training on functional outcomes is needed.

One of the goals of this article was to distill the research evidence to guide clinical practice. A description of the clinical implementation of internal memory strategies as a memory management approach may be found under Clinical Implementation at: http://links.lww.com/JHTR/A149.

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