Aging, Neuropsychology, and Cognition
1999, Vol. 6, No. 1, pp. 56-66
1382-5585/99/0601-056$15.00

Effects of Three Types of Memory Training in Normal Elderly*

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ABSTRACT

The effectiveness of three memory improvement programs, relative to a wait-list condition, was evaluated in residents of a retirement community. The interventions consisted of: (a) a group-based memory course; (b) one of two self-paced, commercially available audiotape memory improvement programs; and (c) individualized, microcomputer-based, memory training. Participants in each condition received approximately 90 minutes of instruction per week for 9 weeks. Memory performance and self-reported memory function and mood were assessed before and after each intervention. Significant performance gains were found in all three groups on the Rivermead Behavioral Memory Test, but these gains were not accompanied by gains in word-list learning or perceived improvement in memory. Whereas participants in all three conditions also reported fewer depressive symptoms after intervention, these changes did not account for the improved memory performance. Participants who showed performance gains with intervention were taking fewer medications and were less likely to have a history of heart disease than those who did not improve. There was little evidence that one intervention was superior to any other, suggesting that mnemonically stimulating activity, rather than any specific process, is responsible for improvement.

It has been reported that the memory of elderly adults can be improved through training. However, the nature of the training that leads to the greatest improvement, and the characteristics of those elderly persons who benefit most from training, remain poorly understood. In their review of this literature, Verhaeghen, Marcoen, and Goossens (1992) identified several variables that are associated with performance gains: younger participants, a group training format, and relatively short training sessions (2 hours or less). The inclusion of attention training, educating participants about memory and aging, and providing group discussions also enhances treatment gains (Verhaeghen et al., 1992).

Despite an extensive literature on memory training in the elderly, several conceptual and practical issues remain relatively unexplored. Conceptually, one could approach the remediation of age-related memory declines through (a) restoration of impaired functions through cognitive exercise and practice; (b) using residual memory and other cognitive skills more efficiently, typically by supporting elaborative encoding at learning and assuring that the relevant cues be present at retrieval; and/or (c) reliance on external aids to support memory (Wilson & Patterson, 1990). There is little evidence that improved performance from practice on a single memory task generalizes to other

* This research was supported by the Charles A. Dana Foundation, The DeVilbiss Fund, and the AARP Andrus Foundation. We express our gratitude towards the residents and staff at the Fairhaven community, especially Alva Baker, Medical Director. We also acknowledge Frances DeQuinque for performing the cognitive testing and Steven Cercy for assisting in the computer-based memory training sessions.
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Accepted for publication: August 20, 1998.

memory tasks or everyday memory functioning (e.g., Payne & Wenger, 1992). Although external aids such as datebooks, alarms, and the like are used frequently among the normal elderly (West, 1989), there are many situations where the use of an external aid is cumbersome or socially awkward. It has been suggested that the most sensible approach to remediation of age-associated memory change is to teach people to use residual skills more efficiently through internal mnemonic strategies or rehearsal techniques (West, 1995).

The majority of memory training studies with community-dwelling elderly have employed a group training approach focusing on learning a single mnemonic technique (e.g., Zarit, Cole, & Guider, 1981; Zarit, Gallagher, & Kramer, 1981). Zarit, Gallagher, and Kramer (1981) have suggested that participating in group sessions that focus on interpersonal and emotional issues can improve elderly adults' memory performance, even in the absence of specific instruction in the use of mnemonic techniques. Flynn and Storandt (1990) found that the combination of individualized mnemonic instruction and a supplementary discussion group resulted in improved memory performance among healthy elderly. Indeed, the meta-analysis of memory training studies by Verhaeghen et al. (1992) showed that those programs where mnemonic strategies were taught showed the greatest improvement. We have found that instructional audiotapes were acceptable, but not particularly effective in improving memory in the elderly (Rebok, Rasmusson, Bylsma, & Brandt, 1997). Despite poor generalizability of performance gains observed on repeated memory tasks, computer technology may represent an opportunity to improve the administration and variety of memory drills (e.g., Gliskey, 1995; Rebok, Rasmusson, & Brandt, 1996). Thus, a variety of approaches to memory training may be effective.

A third question concerns the impact of memory training on perceived memory ability. Recipients of memory training do not always report improved memory even if gains are objectified by tests (Hill, Sheikh, & Yesavage, 1987; Rebok & Balcerak, 1989). Elderly adults appear to require explicit training focusing on perception of memory ability and attributions of memory performance in order to improve self-appraisal of memory function (e.g., Cavanaugh, Morton, & Tilse, 1989; Lachman, Weaver, Bandura, Elliot, & Lewkowicz, 1992). On the other hand, self-report of improved memory function when none is demonstrable by testing (e.g., Scogin & Prohaska, 1992) is difficult to interpret. It may indicate that the participants are correctly perceiving improved functioning in everyday memory that is not measurable by traditional objective tests of memory performance (i.e., our tests are insensitive). Alternatively, participants might be perceiving improvement where there really is none (i.e., our participants are misguided).

The current investigation compared the effectiveness of three approaches to memory intervention in residents of a retirement community averaging nearly 80 years of age. All participants expressed the desire to improve their memories, though none was so concerned as to warrant a clinical evaluation. The interventions consisted of: (a) a group-based memory course, (b) one of two self-paced, commercially available, audiotape memory improvement programs, and (c) an individualized microcomputer-based memory training program. The study also sought to determine the characteristics of those participants who benefit the most from training.

METHOD

Participants

Fifty-three residents of Fairhaven, a continuing care retirement community in rural Maryland, participated. All but one participant were living independently in apartments or cottages; one was residing in an assisted living unit due to physical frailty which required close supervision. Potential volunteers were recruited through advertisements in the community newsletter and a presentation to the community describing the research. Study exclusion criteria were few: (a) a Mini-Mental State Examination (MMSE) score (Folstein, Folstein, & McHugh, 1975) below the 25th percentile for age and education (Crum, Anthony, Bassett, & Folstein, 1993); (b) current participation in a clinical trial of memory-enhancing agent; or (c) untreated major depression or other major mental illness.

Five volunteers were being treated for major depression at study entry. They were accepted into the study because they met the other criteria, had been taking antidepressant medications with adequate symptom relief for six months or longer, and remained on the medications for the duration of the study.

The first 42 volunteers were assigned randomly to one of three memory training programs (14 per group): Memory Course, Audiotape Program, or Microcomputer-Based Training. Two participants assigned to the Memory Course were unable to meet during the time it was scheduled. Of the 40 participants who began training, 5 withdrew from the study: 2 from the Memory Course (1 due to spouse's illness and 1 refused post testing), 2 from the Audiotape Program (1 due to time constraints and 1 because she felt the program was not helpful), and 1 from the Microcomputer-Based Training (due to serious illness). Thus, 35 participants (11 men and 24 women) completed their assigned training and post testing. These participants averaged 78 years of age (range = 65 to 92) and had an average of 15 years of education (range = 8 to 20). Average verbal IQ was estimated at 116 (range = 103 to 127) based on performance on the North American version of the National Adult Reading Test (Blair & Spreen, 1989). In addition, 11 participants (8 men and 3 women) were recruited to serve as *wait-list* controls. These participants agreed to be tested on two occasions, approximately 10 weeks apart, before beginning any actual memory training. They were not significantly different from the participants assigned to the training interventions in age, education, or on any cognitive performance measure at baseline (see Table 1).

Procedure

Memory assessment

Prior to intervention, participants were given a comprehensive Memory Assessment Battery over three sessions lasting 60-90 minutes each. No participant required more than two weeks to complete all testing. Instruments included in this battery are listed in Table 2. They included measures of general cognitive ability, self-reports of memory and mood, and objective measures of immediate memory, new learning, delayed recall, prospective memory, and remote memory for public and autobiographical events of the past. A structured sociodemographic and health interview also was administered to document personal and medical history information. Information regarding current medications was obtained from medical records in the community health center.

A subset of the measures was readministered within two weeks of completing the memory training program (or after an equivalent amount of time had elapsed from initial testing for the control group) and provided the outcome measures. The repeated tests were the following.

The Memory Controllability Inventory (MCI; Lachman, Bandura, Weaver, & Elliot, 1995) is a self-report instrument that yields four primary metamemory scales (Present Ability, Potential Improvement, Effort Utility, and Inevitable Decrement) and two additional ''aging concerns'' scales (Independence, Alzheimer's Likelihood). Each scale is derived from 3 or 4 items on which scores range from 1 (*strongly disagree*) to 7 (*strongly agree*).

The Memory Function Questionnaire (MFQ; Zelinski, Gilewski, & Thompson, 1980) is a memory self-report instrument for appraising one's own memory in seven domains (General Rating, Retrospective Functioning, Frequency of Forgetting, Forgetting During Reading, Remembering the Past, Seriousness Scale, and Mnemonics Usage).

The Geriatric Depression Scale – Short Form (GDS-SF; Yesavage, Brink, Rose, & Adey, 1983) is a checklist of 15 depressive symptoms including mood, somatic symptoms, and cognitive com-

Table 1. Demographic Characteristics of Participants Completing the Study by Training Group.

Variable	Audiotapes (*n* = 12)		Computer (*n* = 13)		Memory Class (*n* = 10)		Wait-List (*n* = 11)	
Age, years	77.1	(8.5)	76.6	(5.6)	80.7	(4.9)	82.30	(9.2)
Education, years	15.8	(2.9)	16.5	(2.7)	14.7	(1.5)	15.0	(2.6)
NART, estimated Verbal IQ	115.6	(7.6)	119.7	(4.7)	113.8	(6.8)	117.2	(4.4)
MMSE	28.0	(1.6)	28.3	(1.3)	27.9	(1.9)	27.2	(1.6)
HVLT, average words/trial	8.0	(2.4)	9.5	(1.7)	8.5	(2.4)	7.3	(2.1)

Note. NART = National Adult Reading Test, MMSE = Mini Mental State Exam, HVLT = Hopkins Verbal Learning Test.

Table 2. Hopkins Memory Assessment Battery.

General cognition:
Mini-Mental State Exam (MMSE)
Wechsler Adult Intelligence Scale – Revised (WAIS-R), selected subtests, reduced items (Vocabulary, Information, and Similarities)
National Adult Reading Test (NART)
Boston Naming Test (BNT)
Category Fluency (Animals, Clothes, Vegetables)
Self-assessment of memory:
Self-Rating Scale of Memory
Memory Controllability Inventory (MCI)*
Memory Functioning Questionnaire (MFQ)*
Everyday Memory Questionnaire (EMQ)
Self-assessment of mood:
Geriatric Depression Scale – Revised (GDS)*
New learning and prospective memory:
WAIS-R Digit Span subtest
California Verbal Learning Test (CVLT)
Hopkins Verbal Learning Test (HVLT)*
Hopkins Prospective Memory Test (HopPro)*
Rivermead Behavioral Memory Test (RBMT)*
Retrospective memory:
Autobiographical Memory Interview (AMI)
Oscar Test

Note. Outcome measures are marked with an *.

plaints. The score was the total number of symptoms endorsed.

Hopkins Prospective Memory Test (HopPro; Rasmusson, Rebok, & Brandt, 1996). The HopPro Phone task requires that the participant telephone the research lab 24 hours after the end of the test session. The participant's response receives a score of 2 if the call is made within 10 minutes of the assigned time, 1 if the call is made more than 10 minutes before or after the assigned time, but not more than one week later, and 0 if the call was made more than one week late or never made.

The Rivermead Behavioral Memory Test (RBMT; Wilson, Cockburn, & Baddeley, 1985) consists of 12 memory tasks: a name-face recall, facial recognition, picture recognition, story recall (immediate and delayed), following a route around the room (immediate and delayed), general orientation, orientation to today's date, and three prospective memory tasks: remembering to ask for the return of a personal belonging, to ask a question, and to deliver a message. Performance on each item receives a score of 0,1, or 2, and these are summed for a total standard score (maximum = 24).

Hopkins Verbal Learning Test (HVLT) – modified (Brandt, 1991) is a 12-item list learning test (with six alternate forms) consisting of three free-recall learning trials and a delayed recall trial (Benedict, Schretlen, Groninger, & Brandt, 1998) followed by yes/no recognition testing. Three outcome measures were tested: (a) average number of items recalled across the four free-recall trials; (b) the percentage retained at delayed recall (relative to the maximum number of words recalled during the learning trials), and (c) discrimination index of recognition performance (true-positives or *hits* minus false-positives).

Memory training protocols

Participants were assigned randomly to one of three memory training protocols, and memory training began within two weeks of completing the baseline testing. To reduce the potential for contamination of conditions, if a husband and wife both participated, they were assigned to the same group, and all participants were instructed not to share specific information about their training with other members of the retirement community. Each intervention condition provided approximately 90 minutes of instruction per week for 9 weeks.

The Memory Course was developed by the Charles A. Dana Consortium on Memory Loss and Aging. Lectures and discussions focused on various types of memory (e.g., short-term vs. long-term, episodic vs. semantic), factors influencing memory (e.g., fatigue, anxiety, depression, alcohol), types of external memory aids and internal strategies (e.g., using a ''memory place,'' chunking), improving reading comprehension and text recall, and learning face-name associations. The final class was devoted to reviewing and practicing the strategies learned during the prior sessions. Homework was assigned and review quizzes were given at the beginning of each class. A more detailed description of the course curriculum is available elsewhere (Mohs et al., 1998).

Audiotape Program participants were randomly assigned to either Nightingale-Conant's *Mega Memory* tapes, or Sybervision's *Neuropsychology of Memory Power* tapes. Both programs consist of 8 two-sided audiotapes and a workbook. Each side of a tape, and the corresponding section in the workbook, constitutes a separate lesson lasting 20-30 minutes. A set of tapes and portable cassette players were provided for all participants. Participants were instructed to complete two lessons per week, and to contact the investigators with any questions or problems. Participants were contacted by phone biweekly to provide encouragement and support and to ensure that they were not experiencing difficulty with the tapes or the tape player. For more detailed description of these programs see Rebok, Rasmusson, and Brandt (1997).

Microcomputer-Based Training participants received instruction and extensive practice on several computerized memory tasks selected from the Colorado Neuropsychology Tests (CNT) software (Davis, Bajszar, & Squire, 1994). Participants were assigned randomly to receive individualized instruction and practice on one of two sets of memory tasks. One set involved primarily explicit learning and recall of new material. The other set measured learning implicitly from faster, more skilled, or more efficient performance on tasks that do not require conscious recollection. Tasks for explicit memory practice were spatial memory for picture pairs, free recall and forced-choice recognition of word lists, temporal order recall of word lists, digit span, and visual pointing span. Tasks in the implicit memory set were reading mirror-reversed text, word-stem completion, a choice reaction-time task with a repeating sequence of spatial positions, and computer adaptations of the Tower of London and the Tower of Hanoi tests. Each session was supervised by a psychologist. Participants' baseline performance on each task served as an index of pretraining ability. Each subsequent practice session was tailored by the psychologist such that the level of difficulty would be well-suited for each participant. As participants improved across sessions, task parameters were manipulated so that the tasks would continue to challenge each person's abilities. For further detail on the tasks and procedures see Rebok et al. (1996).

Statistical Analyses

Participants who withdrew before study completion were compared to participants who completed the study using *t* tests for independent samples, adjusted for unequal variances where necessary.

Because earlier work (see Rebok et al., 1997) suggested that the two audiotape programs did not differ markedly, the data for these two subgroups were pooled. The same was true of the two microcomputer-based training subgroups (see Rebok et al., 1996). The effect of memory training in general on each outcome measure in the Memory Assessment Battery was first assessed by 2 × 2 repeated measures ANOVAs [Group (Memory Training vs. Wait-List Controls) × Session (Baseline and Retesting)]. Significant Group by Session interaction effects indicate that receiving *any* memory training differentially affected performance relative to repeated testing with no training. Such significant interaction effects were further investigated with a series of three 2 × 2 ANOVAs [Group (Specific Intervention vs. Wait-List Controls) × Session (Baseline and Retesting)] to determine which, if any, of the three interventions provided a significant benefit relative to the wait-list condition. This approach was chosen over a 3 or 4 (Group) × 2 (Session) ANOVA because this would not indicate whether each specific intervention was superior to the others, or the Wait-List Controls. The relative effectiveness of the interventions was evaluated by the number of measures on which each proved superior to the Wait-List Controls.

In order to characterize the participants who benefited from training, the entire sample was divided into *Improvers* and *Nonimprovers* on the RBMT as defined below. These two groups were then compared on demographic, medical history, and cognitive performance variables collected at baseline.

RESULTS

Completion of Training

The 5 participants who withdrew from the study had lower MMSE scores, 25.8 versus 28.1, $t(38) = 3.05$, $p = .004$, adjusted for unequal variance, and worse baseline HVLT performance (average items recalled per trial), 7.0 versus 8.7, $t(10, 51) = 2.93$, $p = .01$, than the 35 who completed the study. All 11 wait-list control participants returned for retesting. The participants who completed the study did not differ across the intervention groups in age, education, or any cognitive performance at baseline (see Tables 1 and 2).

Effectiveness of Memory Training Programs

Objective memory performances

No significant effects of Group or Session, or Group by Session interactions, were found on any measure derived from the HVLT. However, there was a significant Group by Session effect on the RBMT, $F(1, 44) = 5.11$, $p = .03$; over time, RBMT scores differed between participants receiving training and those on the waiting list. Comparing each type of training against the wait-list controls (Fig. 1) revealed that the benefits seen on the RBMT were significant for the Computer, $F(1, 22) = 5.07$, $p = .03$, and Memory Course, $F(1, 22) = 7.01$, $p = .01$, but not for the Audiotape Training group, $F(1, 21) = 0.07$, *ns*. There was also a significant Group by Session effect on the HopPro Phone Task, $F(1, 43) = 5.05$, $p = .03$, but here performance actually worsened from baseline to retesting among the intervention participants compared to controls.

Memory self-reports

There were no significant Group by Session interaction effects on any self-report of memory ability from the MFQ or MCI. There were no significant main effects of Session. Although main effects of Group were significant for a few

Fig. 1. Baseline and Retest performance on the Rivermead Behavioral Memory Test (RBMT) shown by intervention condition.

Table 3. Outcome Measures Preintervention and Postintervention. All Values Are Means, Followed by Standard Deviations in Parentheses.

Intervention group	MCI (max = 7)		MFQ (max = 7)		GDS (max = 15)		HVLT (max = 36)		RBMT (max = 24)		HopPro (max = 2)	
Memory Course												
Baseline	4.5	(1.9)	4.3	(1.7)	3.4	(3.8)	25.2	(6.7)	15.7	(4.8)	1.7	(0.6)
Retest	4.7	(1.5)	5.0	(1.3)	1.8	(1.9)	23.6	(7.2)	17.7	(4.9)	1.3	(0.9)
Audiotapes												
Baseline	5.3	(0.9)	4.6	(1.1)	2.3	(2.8)	23.8	(6.8)	17.8	(4.8)	1.8	(0.4)
Retest	5.1	(0.9)	4.7	(1.1)	1.8	(1.9)	23.8	(5.9)	18.4	(4.6)	1.4	(0.6)
Computer												
Baseline	5.1	(0.9)	4.9	(1.1)	1.5	(1.7)	28.0	(5.0)	19.1	(3.5)	1.7	(0.6)
Retest	4.8	(1.3)	4.7	(0.9)	0.8	(1.2)	29.5	(4.4)	20.8	(2.1)	1.4	(0.7)
Wait-List												
Baseline	4.4	(1.0)	4.4	(1.6)	2.7	(3.5)	22.0	(4.9)	18.4	(3.5)	1.3	(0.9)
Retest	3.9	(1.4)	4.0	(1.6)	3.5	(3.5)	21.8	(6.7)	17.0	(3.5)	1.6	(0.7)

Note. MCI = Memory Controllability Inventory (Present Ability Scale), MFQ = Memory Functioning Questionnaire (General Rating), GDS = Geriatric Depression Scale – Revised, HVLT = Hopkins Verbal Learning Test (total items recalled across three learning trials), RBMT = Rivermead Behavioral Memory Test, HopPro = Hopkins Prospective Memory Test (Phone Task). Additional indexes from these measures were derived and tested for training effect as described in the Methods section. A larger table that includes group means for all the outcome measures is available from the corresponding author upon request.

memory self-report subscales, one group did not consistently report more memory concerns or lower efficacy than any other group. Table 3 lists the group means for the general rating scales from each of the two measures.

Mood

A significant Group by Session interaction was found on the GDS, reflecting a decrease in depressive symptoms among the intervention participants, $F(1, 42) = 4.99$, $p = .03$. This interaction effect remained significant after excluding the 5 participants (2 in Audiotapes Group, 3 in Computer Group) who were being treated with antidepressant medications, $F(1, 37) = 5.55$, $p = .02$. Comparing each type of training against the Wait-List condition (Figure 2) indicated that the changes seen on the GDS were significant for the Computer training group only, $F(1, 21) = 6.15$, $p = .02$, although there were strong trends for the other two groups, $p < .10$. In order to investigate the possibility that improved mood was responsible for the RBMT improvement, change scores on the RBMT were correlated with change scores on the GDS. The obtained Pearson correlation ($r = + 0.07$) was clearly not significant, suggesting that improvement on the RBMT was not due to a decrease in depressive symptoms.

Predictors of Improvement on the RBMT

Change scores on the RBMT ranged from –8 to +12. The median and mode change score was zero. Any participant showing an improvement of one point or more on the RBMT was classified as an *Improver* ($n = 20$). Any participant with a stable or declining score on the RBMT was classified as a *Nonimprover* ($n = 26$). Participants receiving training were more likely to be *Improvers* (18 of 35) than those in the Wait-List condition (2 of 11). The Wait-List control participants were excluded from the following analyses so that we could assess response to intervention only, rather than a pure practice effect potentially present among those participants.

Chi-square analysis showed that the Improvers and Nonimprovers did not differ significantly in the distribution of sex, marital status, handedness, past psychotherapy, or family

Fig. 2. Baseline and Retest Geriatric Depression Scale – Revised (GDS) shown by intervention condition.

history of psychological disorders. *t* tests were used to assess group differences on continuous variables collected at baseline. These variables were age, education, total number of medications, self-reported weekly alcohol consumption, and scores on MMSE, NART, verbal fluency, HVLT, HopPro – Phone Task, MCI, MFQ, and GDS. The only significant finding was that the Improvers were taking fewer total medications (2.1, *SD* = 1.5) than the Nonimprovers (4.1, *SD* = 2.9), $F(1, 34) = 5.86$, $p < .05$. Specifically, Nonimprovers were significantly more likely to be taking anticoagulants, $\chi^2 = 8.11$, $p = .005$, and miscellaneous medications such as antihistamines (e.g., Benadryl) or antilipemic agents (e.g., Mevacor), $\chi^2 = 4.92$, $p = .02$. Analyses of medical histories revealed that a history of heart disease was reported more often in Nonimprovers (89%) than in Improvers (6%), $\chi^2 = 7.88$, $p < .005$.

DISCUSSION

This study addressed four major questions: (a) Can memory performance in a cohort of very old adults be improved by memory training? (b) Which of three distinct approaches to memory training has greater impact on memory performance? (c) Do self-perceptions of memory functioning, actual memory performance, or mood improve to the same degree following training? and (d) Are there specific characteristics that predict who will benefit the most from memory training? In general, the results suggest that older adults who received training showed (a) modest gains in performance on the RBMT; (b) no training benefits in word recall on the HVLT; (c) decline on a prospective memory task; (d) no change in self-reports of memory function; (e) improved mood; and (f) greater benefit from intervention in the absence of heart disease and/or numerous medications.

Despite the diversity of the interventions, no one memory intervention was superior to the others. However, only the Computer training participants showed significant improvements on both the RBMT and GDS relative to the Wait-List control participants, and the Audiotape Group did not differ significantly from the Wait-List control group on either measure (*ps* < .10). The benefit of the mnemonics taught in the Group Memory Course and Audiotape Training Group may not have been fully realized within the study period. Mnemonic methods and rehearsal strategies are complex skills that must be learned. However, nine weeks is rather long compared to the hours or days of training offered in many prior studies. In the present study's group format, much time was allocated for lecture and discussion, but not much time for practicing the techniques. It is possible that participants in this and other studies did not have enough opportunity to practice and perfect the new skills presented to them. West (1989) has noted that most studies of memory training have not verified that participants actually use the mnemonic methods that were taught. On the other hand, the computer-based training provided practice, but no new strategies, for the participants to use in their practice sessions. The performance gains seen in the computer group may be due to cognitive exercise itself, the self-generation of more efficient mnemonic strategies (e.g., Hill, Allen, & Gregory, 1990), or a combination of the two. If the gains from the computer-based training were due to cognitive exercise alone, then we may observe a decrease over time as the benefits derived from the memory drills fade. Longitudinal outcome studies of these groups are currently underway. Neely and Bäckman (1993) found that elderly participants in a multifactorial memory training program maintained improvements above preintervention levels 3.5 years after training.

Future memory interventions may have even greater impact on memory performance if approaches or technologies are combined. That is, mnemonic strategies could be introduced through lecture or reading, and then self-paced, structured practice sessions could be done in the computer laboratory or at home. Although the present study used a variety of modern technologies, their visual aspects were minimal. A number of our elderly participants reported difficulty in using the visual imagery techniques that were presented to them in the memory course or audiotapes (see Rebok et al., 1997); West (1989) and West, Yassuda, and Welch (1997) also note this difficulty. However, West and her colleagues have found that instructional videotapes illustrating imagery-based mnemonic techniques were effective in improving older adults' performance on several memory tests (West & Crook, 1992; West et al., 1997).

None of the outcome measures in the present study were presented as target tasks which the training would address specifically. Rather, all the performance outcome measures were tasks on which one might generalize the techniques or skills learned in training. Thus, greater improvements may have been seen had the participants been ''trained to task.'' In fact, the computer training participants improved greatly on the tasks on which they trained (Rebok et al., 1996). The outcome battery was chosen as a broad net to capture any changes in performance or self-reported abilities from the interventions, but we are unable to dissect the theoretical basis, or the relative generalization of the benefits observed.

An unexpected decline in performance on the HopPro Phone Task was observed among intervention participants. Because the prospective memory task was the last task administered in the post testing session, and the task itself was to be completed 24 hours after what may have been perceived as the completion of a three-month-long study, intervention participants may have been less motivated to complete this task at post-intervention testing than at baseline. The finding that RBMT performance, which was completed within the session, improved with all forms of training supports this contention. This finding, therefore, may reflect the sensitivity of prospective memory performance to motivational factors, as previously suggested by Tombaugh, Grandmaison, and Schmidt (1995).

Memory intervention was associated with reduced depressive symptoms, as assessed by the GDS. This effect remained significant even after participants who were on antidepressant medication were removed from the analysis. Although the participants in this study were already relatively healthy and active members of a retirement community, it is possible that their participation in these interventions contributed to their overall feelings of self-worth. The benefits observed on the RBMT and GDS appear to be independent of each other.

A major goal of the present study was to determine whether certain characteristics of older persons could predict who would benefit most from memory training, regardless of the type of training received. The Improvers in this study had better health, rather than better baseline cognition, as others have reported (e.g., Hill, Yesavage, Sheikh, & Friedman, 1989). Specifically, it appears that a history of heart disease, and/or taking anticoagulant or other medications, may prevent or limit the potential benefits of the memory interventions studied here. Previous research has reported decreased cognitive function in patients surviving cardiac arrest (e.g., Roine, Kajaste, & Kaste, 1993). Similarly, Albert et al. (1995) found participation in vigorous activity and higher pulmonary peak expiratory flow among the variables predicting both the concurrent level and longitudinal maintenance of cognitive performance. Thus, primary prevention of heart disease through improved nutrition and cardiovascular fitness may contribute to the preservation and plasticity of cognitive functioning.

The demand for effective and enjoyable approaches to the remediation of age-related memory changes will increase as the population continues to age. Results from the present study suggest that there are several options for the remediation of age-related memory decline. Future study of the maintenance of the gains shown here may further support the benefits of the three interventions.

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