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The Effect of Memory Training on Memory Control Beliefs in Older Adults with Subjective Memory Complaints

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ABSTRACT

Objective: To study whether memory control beliefs predict response to memory training, or change as a result of participating in memory training.
Methods: Eighty community based participants with subjective memory complaints Community-based study at UCLA were randomized to one of three conditions: *Memory Training*, the program consisted of weekly 120-minute classes featuring instruction in three specific strategies: Method of Loci; Chunking Technique; and Face-Name Association, *Health Education* or *Wait-List* over seven weeks. All participants underwent pre- and 1-week post-intervention follow-up memory testing for recalling word lists (in serial order and any order) and face-name pairs. Memory control beliefs were assessed at baseline and follow-up using the Memory Controllability Inventory, which consists of four subscales; Present Ability; Potential Improvement; Effort Utility; and Inevitable Decrement.
Results: Sixty-three participants (mean age [SD] 68.3 [6.7] years) were included in the analysis. ANCOVA revealed significant group differences in the Present Ability subscale, $F_{2,58} = 4.93$, $p = .01$. Participants in the Memory Training group significantly improved on the Present Ability subscale compared to the Health Education group (mean difference =.96, SE =.31, $p = .003$, effect size = 0.93). From regression analyses, baseline Memory Controllability Inventory subscales did not significantly predict memory performance after memory training.
Conclusions: Baseline memory control beliefs did not predict memory performance following the intervention, but participating in memory training enhanced memory control beliefs about current memory function. These results suggest that participating in memory training can enhance confidence in one's memory ability.

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Introduction

Memory complaints are common among older adults with normal aging, as well as those with neurocognitive disorders (Minett, Silva, Ortiz & Bertolucci, 2008; O'Connor, Pollitt, Roth, Brook, & Reiss, 1990; Verhaeghen, Geraerts, & Marcoen, 2000). Based on research in animals (van Praag, Kempermann, & Gage, 2000) and humans (Boyke, Driemeyer, Gaser, Büchel, & May, 2008; Brehmer, Kalpouzos, Wenger, & Lövdén, 2014), memory demonstrates "plasticity"

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or the potential for modification when conditions are optimized. Epidemiological studies indicate an association between cognitive stimulation and reduction of dementia risk (Wilson et al., 2003, 2002). Public interest in proactively enhancing and preserving cognition through memory and cognitive training is rapidly increasing in popularity.

Various clinical trials and systematic reviews have shown that cognitive training interventions can improve memory and other cognitive functions in older adults with age-related declines and even leads to structural and functional brain changes (Dresler et al., 2017; Engvig et al., 2010). Meta-analyses have also indicated the effectiveness of memory enhancement strategies (Gross et al., 2012; Karbach & Verhaeghen, 2014; Verhaeghen, Marcoen, & Goossens, 1992). Most effective strategies typically involve the use of association, rehearsal, imagery, organizational techniques, use of retrieval cues, optimization of personal meaning, enhancement of novelty, and strengthening of associations to preexisting knowledge, all of which facilitate learning and recall (Savage, Rose, & Bower, 1983; Yesavage, 1982, 1984; Yesavage & Rose, 1984). Other important elements also are included in memory training interventions. For instance, "pretraining" in the basic elements of memory strategies (e.g., teaching participants how to form associations and visual images) can enhance the learning of specific, more complicated memory techniques (Verhaeghen et al., 1992; Yesavage, 1983). Other strategies, such as small group training sessions and session durations lasting between 60 and 90 minutes, also are associated with greater treatment gains (Verhaeghen et al., 1992).

Despite the effectiveness of memory training, there is still considerable variability in the response to memory training among cognitively intact older adults (Ball et al., 2002; Craik et al., 2007; Gross et al., 2012; Karbach & Verhaeghen, 2014; Verhaeghen et al., 1992). Some people show great gains from memory training, while others show minimal benefit. Uncovering internal factors that mediate the response to memory training would be important for maximizing the benefits of memory enhancement interventions, and would be crucial for determining the best candidates for such interventions.

One internal factor that may affect the response to memory training is memory control beliefs (Lachman, 2000; Lachman, Steinberg, & Trotter, 1987). The concept of memory control beliefs, or beliefs about one's ability to exert control over their desired memory performance, is based on social learning theory (Bandura, 1989) and is related to concepts such as self-efficacy, sense of control, perceived control, and locus of control (Valentijn et al., 2006; West, Bagwell, & Dark-Freudeman, 2008). Control beliefs, in general, relate to people's beliefs that they have control over the possible or various outcomes in their life (Lachman, 2000). Persons with a high sense of memory control are likely to be confident about their memory and believe that they can improve or sustain their memory functions with use, effort, or compensatory strategies. By contrast, people with low memory control tend to believe that memory is fixed and unmodifiable and have low confidence and low motivation for using their memory. They exert low levels of effort and may take less action to improve their memory. Such avoidance and disuse can, in turn, negatively impact their daily functioning, resulting in greater dependency on others (Lachman & Andreoletti, 2006; Valentijn et al., 2006).

The issue of negative outcomes due to low memory control beliefs raises the question as to whether it is possible to modify memory control beliefs among older adults who believe that memory ability is fixed, and not amenable to intervention (Lineweaver & Hertzog, 1998; Ryan, 1992). Lachman, Weaver, and Bandura (1992) found that older adults can improve their

perception of memory ability effectively when exposed to a combination of memory training and cognitive restructuring, which promotes the adaptive beliefs about their own abilities. Still, studies on the contributions of memory training on memory control beliefs, and vice versa, are limited. To address such knowledge gaps, the current pilot study was designed to explore (1) whether memory control beliefs change as a function of participating in a memory training program compared to a health education condition and a wait-list condition; and (2) whether memory control beliefs predict cognitive improvement as a result of participating in a memory training intervention.

Materials and Methods

Participants

For this randomized controlled trial, we recruited participants with memory complaints through community talks, newspaper advertisements, flyers and word-of-mouth. After completion of a phone screen for eligibility, potential study participants were scheduled for an in-person screening, baseline interview and informed consent. Inclusion criteria included: (1) age 50 years or older; and (2) a Mini-Mental Status Examination (MMSE) score of ≥24 (M.F. Folstein, Folstein, & McHugh, 1975). Potential volunteers were excluded for one or more of the following reasons: (1) diagnosis of dementia (according to DSM-IV-TR criteria) (American Psychiatric Association, 2000); (2) major medical conditions severe enough to impact cognitive abilities (e.g. stroke, neurological illness, significant cardiac disease; history of head injury with loss of consciousness); (3) moderate to severe symptoms of depression as measured by a Geriatric Depression Scale (GDS) score of ≥11) (Yesavage et al., 1983); (4) diagnosis of serious mental illness (e.g. schizophrenia, psychotic disorder) or active substance abuse; (5) significant visual or hearing impairment that precludes participation; or (6) non-fluency in English. The study was approved by the institutional review board at the University of California, Los Angeles (IRB number: G01-06-041-01).

Measures and Study Design

Eligible subjects completed baseline cognitive tests, which included the Wechsler Adult Intelligence Scale-III (WAIS-III) Digit Span, Digit Symbol, Similarities; the Wechsler Memory Scale-III Verbal Paired Associate (WMS-III, VPA) Learning Test; and, Trails A and B (Wechsler, 1997). Subjects completed a subjective assessment of memory functioning, the Memory Functioning Questionnaire (MFQ) (Gilewski, Zelinski, & Schaie, 1990). The 64-item questionnaire measures self-perception of general frequency of forgetting, seriousness of forgetting, retrospective functioning, and mnemonics usage. All questions are rated on a 7-point scale. After baseline cognitive testing, subjects were randomly assigned to one of three groups: Memory Training (MT) intervention, Health Education (HE) active control group; or Wait-List (WL). Subjects also underwent memory testing on the dependent variables (word lists and face-name recall) one week prior to the interventions, and these tests were repeated at one week after the end of interventions. The WL group underwent testing at the same intervals as the active conditions.

Intervention

Memory Training Group (MT)

The two-hour MT intervention held once weekly included pretraining on the basics of memory functioning (i.e., forming associations and visual images), addressing non-cognitive factors such as self-confidence, anxiety reduction, and countering negative expectations; and, assigning home practice exercises (Verhaeghen et al., 1992). Subjects in the MT group were given make-up sessions if they were absent. Subjects learned three specific memory strategies.

Method of Loci ***(Yesavage & Rose, 1984).*** Used to recall *a list of words in serial order* and involves forming a visual image associating to-be-learned items with loci (landmarks or "memory spots") along a well-known path. Furniture or other notable objects in rooms serve as the landmarks which are memorized in order and used over and over again. Subjects then take a mental "walk" along the path, forming an image associating the first item on the list with the first landmark, the second item on the list with the second landmark and so forth. Subjects then judge the "pleasantness" or "unpleasantness" of the visual image to add more meaning to the association.

Chunking Technique ***(Gobet et al., 2001).*** Used to recall *a list of words in any order* and involves subdividing a large amount of to-be-learned information into smaller and meaningful "chunks" or subgroups according to some common function or feature. Each subgroup is then given a label related to what the items share in common. To recall the items, participants remember the subgroup label, which then triggers recall for the specific items.

Face-name Associations ***(McCarthy, 1980).*** Used for learning the names and faces of new people. It involves forming a vivid image associating a prominent feature of someone's face with a concrete or meaningful transformation of that person's name. Subjects also judge the "pleasantness" or "unpleasantness" of the visual association image (Yesavage, Rose & Bower, 1983). Recalling the image-transformed name association triggers recall for the face and name.

For standardization, the trained MT instructors used a course manual to present the curriculum. Subjects were assigned home practice exercises. Each group was comprised of 10 or fewer subjects.

Health Education (He)/active Control Group

The HE condition controlled for nonspecific mental stimulation, experimenter contact and social aspects of the MT group. HE subjects received weekly structured informative lectures on health topics delivered by medical and research staff and guest lecturers with expertise in the areas of discussion (e.g. exercise, depression, nutrition, anxiety, and medication side-effects). Each HE instructor developed their lecture and visual/slides to go with it. The HE schedule was identical to the MT schedule. The HE intervention mimicked the MT intervention with structured presentations followed by group discussion as well as readings and take-home information for home study. The HE condition excluded topics related to memory training or memory function. HE subjects were given the prior week's materials if they missed a session.

Wait-list (WI)/control Group

The WL group was a control for repeated neuropsychological testing. WL subjects received only baseline and post-condition testing.

Subjects in both control conditions were told, in advance of their participation, that they would receive the MT intervention once their intervention group participation was completed. Subjects in both the HE and WL conditions were instructed not to learn about memory enhancement strategies during their participation in the study.

Memory Testing Procedures and Dependent Variables

Subjects were tested in their respective study groups to prevent cross-group discussion of the interventions.

Word List Recall

The examiner asked subjects to study two 12-item word lists for 2 minutes and then to recall them 20 minutes later. Each list was presented on a standard-sized 8 x 11-inch piece of paper. Both lists were comprised of words with high imagery and high concreteness ratings (Paivio, Yuille, & Madigan, 1968). One list was comprised of words that could be organized into semantically related subgroups and subjects were told that they could recall that list in *any order* (favoring chunking technique usage). The other list was comprised of unrelated words, and subjects were told to recall the words in *the same serial order as presented* (favoring Method of Loci method usage). Subjects were not instructed to use any particular method to recall the words of either list. The Any Order list was scored according to the number of total words recalled; the Serial Order list was scored according to the number of words recalled in correct serial order. Alternate forms were counterbalanced within and between groups.

Face-name Recall

Six videos using volunteers as actors stating a fictitious name and city in which they lived were professionally produced at UCLA, following a method previously used by West, Yassuda, and Welch (1997). Each video included 10 actors and were edited to be comparable with respect to gender and ethnic and racial diversity. Videos included a learning portion and a recall portion. In the learning portion, actors introduced themselves using a fictitious name (e.g. "Hello, my name is Cassie Fontaine"). Subjects were asked to study each individual for 10 seconds and told to remember the face and name as best they can. For the recall portion, after a 20-minute delay, the same actors were presented in a different order, this time stating only a fictitious city in which they lived for voice recognition (e.g. "Cassie Fontaine" was shown again, stating "I come from New Orleans, Louisiana").

The outcome variable was total recall for the 10 face-name associations, which was scored from 0 to 20 (one point for recalling the first name and one point for recalling the last name). To minimize rehearsal and interference, the face-name test was administered between the two word-list recall tests.

Memory Control Beliefs Measurement

Each subject completed a self-report measurement of memory control beliefs using the Memory Controllability Inventory (Lachman, Bandura, & Weaver, 1995) at the baseline and one-week post-intervention. The Memory Controllability Inventory has 12 items,

comprising four subscales that reflect beliefs about memory control (see Table, Supplemental Online Material 1). Subjects rated the degree to which they agreed or disagreed with each statement on a 7-point scale (from strongly disagree to strongly agree). The subscales include:

- ***Present Ability.*** Beliefs about current memory function;
- ***Potential Improvement.*** Beliefs about whether one can find ways or use strategies to improve memory;
- ***Effort Utility.*** Beliefs that memory could improve with use or effort
- ***Inevitable Decrement.*** Beliefs that there is little one can do to prevent or compensate for age-related memory losses.

For the first three subscales, higher scores indicate more positive memory control beliefs. For Inevitable Decrement, a lower score represents more positive memory control beliefs.

Statistical Analyses

Baseline demographics of the three groups were compared using chi-square tests for the categorical measures and 0ne-way analysis of variance (ANOVA) for the continuous measures. Changes in memory control beliefs and memory performance scores between the three groups were compared using analysis of covariance (ANCOVA) models (with group as predictor, baseline score and age as covariates, follow-up score as dependent variable). Significant between-group differences were examined with post-hoc tests for assessing specific pair-wise group differences. The significance threshold was set at 0.017 (0.05/3; two-tailed) for each of the three memory performance measures and at 0.0125 (0.05/4; two-tailed) for the four subscales of the Memory Controllability Inventory. We also reported effect size (ES) as measured by Cohen's d for significant differences. Within the MT group only, we examined whether baseline memory control beliefs predicted change in memory performance variables using separate general linear models for each of the three memory performance scores and each baseline Memory Controllability subscale as a predictor, with age and baseline memory scores as covariates.

Results

A total of 126 people volunteered for the study, and 46 of them were determined to be ineligible at the initial telephone screening (current major medical disorder n = 5; referred out/actively depressed n = 1; currently taking antidepressant medication n = 2, outside of age range n = 7); or were excluded because they were not interested or could not be reached for further screening (n = 31). As a result, 80 subjects were randomized: 30 to the MT group, 26 to the HE group, and 24 to the WL group. There were eight dropouts between pre-intervention and post-intervention (four from MT, one from HE and three from WL). There were no significant differences between completers and dropouts in terms of age, gender, educational level, MMSE, WAIS-III and GDS. In addition, nine subjects (three from

MT, two from HE, and four from WL) were excluded due to an error in test counterbalancing. Thus, 63 subjects were included in the final analysis (Figure 1).

Demographic Data

Subject groups did not differ significantly in age, education, GDS, MMSE, or MFQ scores at baseline (Table 1).

Memory Performance

ANCOVA analyses indicated that treatment groups did not differ significantly in changes on any of the memory performance scores: word list recall in serial order ($F_{2,58}$ = 2.18, p = .12), word list recall in any order ($F_{2,58}$ = 2.21, p = .12), or face-name recall ($F_{2,57}$ = 1.43, p = .25) (Figures 2–4).

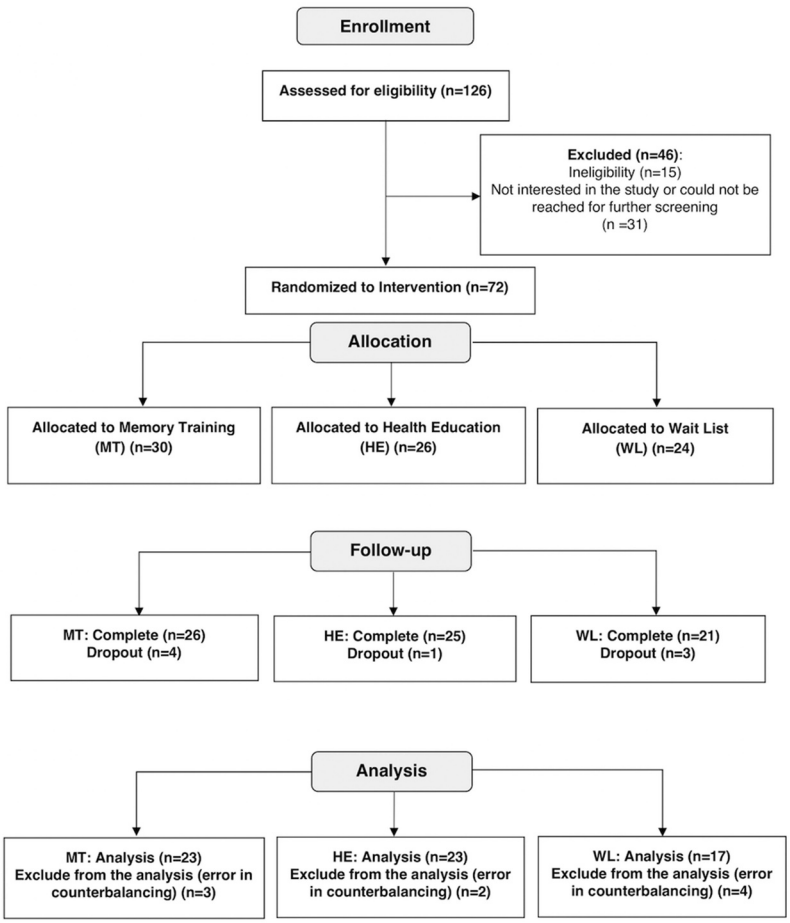

Figure 1. Study flowchart.

Table 1. Baseline clinical characteristics.

	MT (n = 23)		HE (n = 23)		WL (n = 17)		
Characteristics	*M*	*SD*	*M*	*SD*	*M*	*SD*	*p*
Age (years)	67.26	6.87	67.78	6.57	70.29	6.74	.34
Education (years)	16.78	2.26	16.22	2.41	15.71	2.37	.36
MMSE	28.74	1.18	28.91	1.04	28.47	0.94	.44
GDS	4.17	2.06	4.48	3.06	4.47	3.18	.92
MFQ							
- General Frequency of Forgetting	147.35	24.40	151.91	22.42	142.0	37.93	.55
- Seriousness of Forgetting	76.57	19.62	79.09	18.79	79.82	20.47	.85
- Retrospective Functioning	13.57	3.75	13.96	6.26	11.0	4.84	.16
- Mnemonics Usage	22.22	8.96	20.87	7.09	23.0	8.82	.71
Baseline Memory Performance							
- Word List Recall (Serial Order)	3.70	3.24	4.70	3.90	2.59	2.72	.16
- Word List Recall (Any Order)	8.35	2.90	8.83	2.71	7.35	3.82	.34
- Face-Name Recall	3.65	3.55	3.39	4.11	3.13[a]	4.44	.92
	n	%	*n*	%	*n*	%	*p*
Ethnicity: White	21	91.30	22	95.65	14	82.35	.31
Gender: Women	17	73.91	19	82.61	9	52.94	.12

MT, Memory Training group; HE, Health Education group; WL; Wait List group; MMSE, Mini-Mental State Exam; GDS, Geriatric Depression Scale; MFQ, Memory Functioning Questionnaire. Mean differences were tested with ANOVA models for the continuous measures and chi-square tests for the categorical measures. [a] For Face-name recall in WL group, a total number is 16.

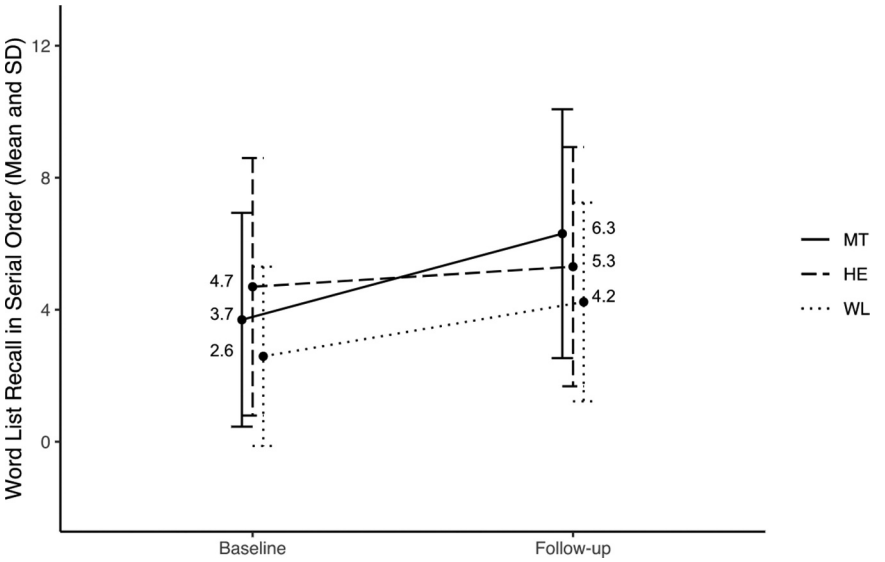

Figure 2. Word list recall in serial order.

Memory Controllability Inventory Subscales

Significant between-group differences were observed for the Present Ability subscale improvement ($F_{2,58}$ = 4.93, p = .01) (Table 2). No significant between-group differences were found for changes in the other subscales. Within-group analyses for the Present Ability subscale revealed that the MT group improved significantly from baseline to post-intervention ($t_{(22)}$ = 3.25, p = .004) while the other two groups did not show significant

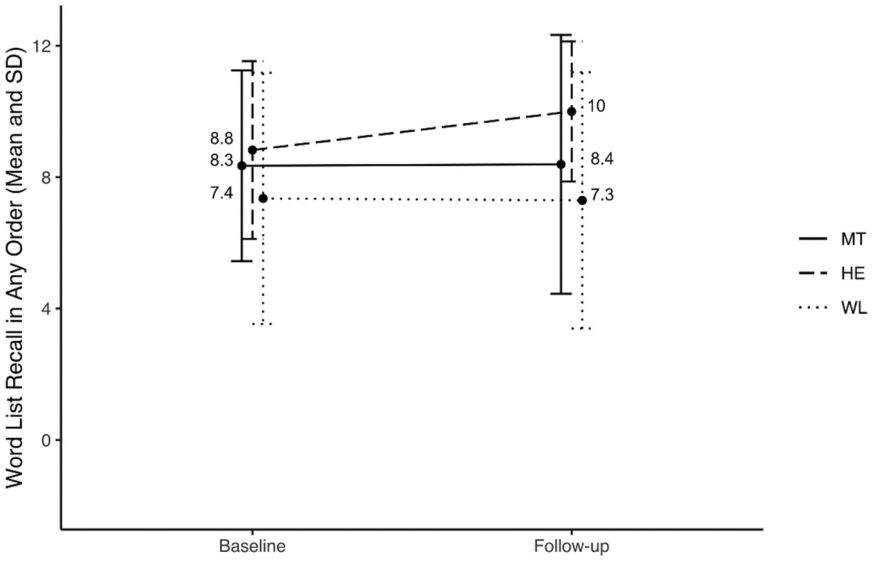

Figure 3. Word list recall in any order.

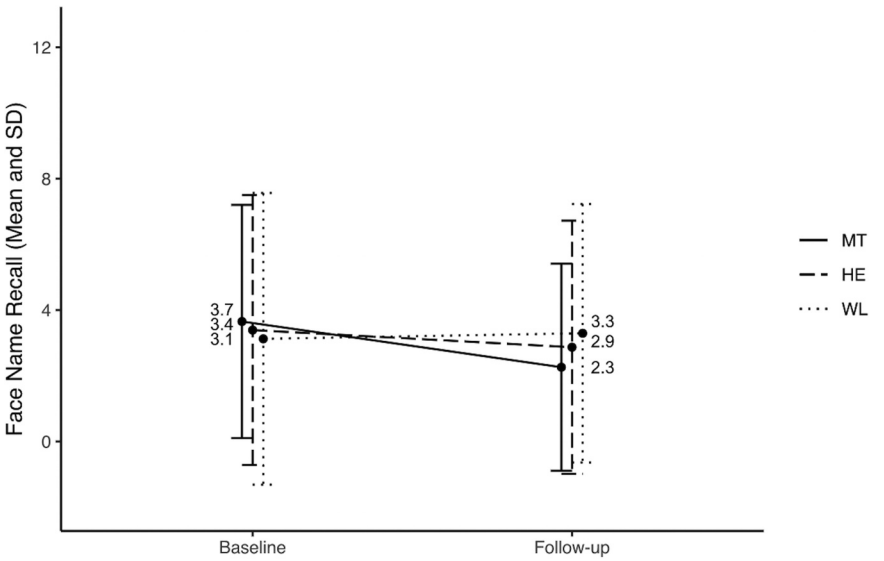

Figure 4. Face name recall.

change (HE: $t_{(22)} = -1.5$, $p = .15$; WL: $t_{(16)} = 1.84$, $p = .09$). Post-hoc analyses revealed that the Present Ability improvement in the MT group was significantly greater than the change in the HE group (mean difference = .96, SE = .31, $p = .003$) with effect size = 0.93. There were no significant differences in Present Ability change between the MT and the WL groups (mean difference = .49, SE = .34, $p = .16$) and between the HE and the WL groups (mean difference = −.47, SE = .35, $p = .18$).

Table 2. The memory controllability inventory subscales at baseline and follow-up.

		Baseline		Follow-up		
Memory Controllability Inventory Subscales		*M*	*SD*	*M*	*SD*	Between Group Comparison
Present Ability[1]	MT	4.23	1.20	5.17	1.23	***$F_{2,58}$ = 4.93, p =.01***
	HE	4.65	0.96	4.35	0.88	
	WL	3.80	1.14	4.43	1.18	
Potential improvement[1]	MT	5.13	1.21	5.74	1.14	$F_{2,58}$ = 2.22, p =.12
	HE	5.61	0.84	5.54	1.03	
	WL	4.90	0.88	4.90	1.01	
Effort Utility[1]	MT	5.57	0.94	5.98	1.13	$F_{2,58}$ = 1.21, p =.31
	HE	5.61	0.91	5.55	1.10	
	WL	5.63	0.89	5.98	1.13	
Inevitable Decrement[2]	MT	3.33	0.99	2.60	1.24	$F_{2,58}$ = 1.37, p =.26
	HE	3.09	1.37	2.96	1.31	
	WL	3.22	1.12	2.59	1.24	

MT, Memory Training group; HE, Health Education group; WL; Wait List group. [1]Higher scores indicate more positive memory control beliefs; [2]Lower scores indicate more positive memory control beliefs. Between-group comparisons were tested with ANCOVA models (group as predictor, Memory Controllability Inventory subscales at baseline and age as covariates, Memory Controllability Inventory subscales at follow-up as dependent variable).
The significant level of *p*-value was set at 0.0125.

After controlling for age and baseline memory performance, baseline Memory Controllability Inventory scores were not significantly associated with follow-up scores of Serial Order or Any Order word list recall or face-name recall for the MT group ($F_{1,19}$ = .002–2.91, p = .1 – .96).

Discussion

The major findings of the study were that (1) participants who underwent a 7-week memory enhancement intervention did not demonstrate improvement in memory performances compared to control groups; (2) participants reported increased confidence in their memory abilities after the memory training intervention compared to subjects who had the HE intervention; and (3) memory control beliefs at baseline did not predict response to memory training.

Our finding that memory training did not improve recall on objective memory measures compared to control groups was not consistent with those reported in a previous meta-analysis that showed significant effects of memory training on serial word recall using the Method of Loci technique in older adults (Verhaeghen et al., 1992). Another clinical trial of older adults, however, has demonstrated a lack of significant findings on memory outcome variables (Craik et al., 2007). In the ACTIVE study (Ball et al., 2002), a multi-cite study on the effects of memory, reasoning and speed of processing training in older adults, training specific improvements were found for speed of processing and reasoning training, but not for memory training. One explanation for the lack of improvement is that verbal memory is susceptible to practice effects, as was found in the ACTIVE study, where about 26% of control subjects showed a reliable gain in test performance (Ball et al., 2002). The group performances in our current study (Figure 2, word list recall in serial order) suggested practice effects in the WL group. In the current study, it is possible that some WL participants learned memory strategies outside the study because of their interest in improving their memory and impatience in waiting until after the study to receive memory training. Another possible explanation is that both the Method of Loci and Face-Name techniques were too challenging for the study participants (Bender, Naveh-Benjamin, Amann, & Raz, 2017; Naveh-Benjamin et al., 2009).

Consistent with that explanation is the observation that the MT group showed a decline in face-name recall after training (Figure 4).

Our results indicate that memory training can result in improved beliefs and confidence about one's memory ability; however, beliefs about memory ability did not predict who benefited from memory training. Our findings are consistent with those of Lachman, who reported that memory control beliefs may be modified by both cognitive restructuring and memory training (Lachman et al., 1992). Having positive attitudes about memory is not required for people to benefit from memory training. Thus, regardless of people's beliefs at baseline, memory training interventions can improve self-confidence about memory functioning. In fact, memory training may restructure one's confidence in their memory ability by providing education about how memory works, providing mastery experiences, and broadening one's repertoire of memory enhancement techniques.

These findings also have implications for daily functioning. Memory control beliefs are postulated to be both antecedents and consequences of memory performance in aging population. As consequences, persons with declining memory may lose confidence in their abilities and develop more negative thinking (Miller & Lachman, 1999). As antecedents, less confidence in memory abilities and reduced sense of control over offsetting future memory declines may result in greater anxiety, low levels of effort, and ultimately decrements in function and memory performance (Lachman & Andreoletti, 2006; Valentijn et al., 2006). These results indicate that memory training can lead to a positive change in memory control. People who feel a stronger sense of control over their life may be more inclined to partake in behaviors or lifestyle choices associated with more positive health outcomes (Lachman, 2000). Those who have higher memory control may be more likely to use effective strategies to boost their memory functioning (Lachman & Andreoletti, 2006).

The current study has several limitations, the most important one being the small sample size. The study sample was not very diverse in terms of racial and ethnic make-up, and thus findings have limited generalizability. In addition, subjects were aware of their group membership after randomization, which may have affected their test-taking attitudes at baseline. Because of limited resources, some of the investigators who initially conceptualized the study intervention also gave one lecture in the Health Education control group, which raised the risk of a threat to internal validity. Outcome measures may not have been adequately sensitive to memory change. Although outcome measures were developed based on prior research (Paivio, Yuille, & Rogers, 1969; West et al., 1997), they were not validated on a larger sample.

Future studies may improve upon the current one by including only active control groups, a larger and more diverse sample, baseline testing prior to randomization, and using standardized outcome measures for memory testing.

Conclusion

The current findings indicate that although a memory training intervention did not improve objective memory performance beyond that which could be attributed to practice effects. Participating in memory training improved beliefs in one's memory abilities. In addition, the level of memory control at baseline was not predictive of benefit from a memory training intervention.

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