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The Influence of Cognitive Training on Older Adults' Recall for Short Stories

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Abstract

Objectives—This paper investigated how a multi-component memory intervention affected memory for prose. We compared verbatim and paraphrased recall for short stories immediately and 1-, 2-, 3- and 5-years post-intervention in the ACTIVE (Advanced Cognitive Training for Independent and Vital Elderly) sample.

Methods—We studied 1,912 ACTIVE participants aged 65–91. Participants were randomized into one of three training arms (Memory, Reasoning, Speed of Processing) or a no-contact Control group; about half of the trained participants received additional booster training 1 and 3 years post-intervention.

Results—Memory-trained participants showed higher verbatim recall than non-memory-trained participants. Booster memory training led to higher verbatim recall. Memory training effects were evident immediately following training and not after one year following training.

Discussion—Results suggest that multi-factorial memory training can improve verbatim recall for prose, but the effect does not last without continued intervention.

MeSH key words

Memory; short-term; prose recall; aged; intervention studies; longitudinal studies

Introduction

Memory for prose is especially relevant to the daily function of older adults (Johnson, 2003). Much new learning in late life comes from spoken and written prose in newspapers, books, conversation, television, and radio (Britton & Black, 1985). Older age is associated with declines in prose memory (Zelinski & Stewart, 1998), and worse prose recall performance compared to younger adults (Hartley, 1989; Light, 1991; Verhaeghen, Marcoen, & Goosens, 1993). The Advanced Cognitive Training for Independent and Vital Elderly (ACTIVE; Ball et al., 2002; Jobe et al., 2001) study aimed to improve prose memory as part of a broader cognitive intervention that instructed community-living older adults in both general mnemonic strategies and in a hierarchical structure strategy specific for prose recall, which is described below.

Many memory interventions for older adults are intended to improve verbal memory broadly, rather than prose memory in particular. Short-term interventions teaching general mnemonic strategies such as visualization and association have been shown to improve older adults' prose memory (e.g., Hohaas, 2007; Scogin & Prohaska, 1992) more than alternative approaches to mnemonic training such as process-specific (e.g., Bueschkuhl, Jaeggi, Hutchison, Perrig-Chiello, et al., 2008) or plasticity-based adaptive training (e.g., Smith, Housen, Yaffe, Ruff, et al., 2009). Other evidence suggests these improvements may not endure beyond two years (Bottiroli, Cavallini, & Vecchi, 2008). Rasmusson, Rebok, Bylsma, and Brandt (1999) found that three interventions teaching mnemonic strategies to older adults using different modalities (group-based course, self-paced audio-cassette, and individualized microcomputer based training) all led to equally-improved prose memory on the Rivermead Behavioral Memory test. Another mnemonic strategy-based training program produced improvements in recall specifically for the details of prose, without conferring benefits on total recall (Craik et al., 2007). Mnemonic training alone is even associated with better memory for prose sentences and paragraphs than an intervention combining mnemonic strategies and a change-of-beliefs component, suggesting general mnemonic training is a particularly important component of training for prose memory (Yassuda, 1999).

In contrast to the general mnemonic approach, identifying a passage's hierarchical structure, and organizing it into main ideas and details is another effective mnemonic strategy (Pressley & McCormick, 1995). Use of this hierarchical structure strategy approach is associated with better prose memory in high school students (Meyer, Brandt, & Bluth, 1980), young adults, and older adults across a variety of texts (Meyer & Poon, 2001). Older adults who received structure strategy training also reported improvements in the information they remembered in their everyday lives (Meyer & Poon, 2001). Some interventions broadly targeting memory in older adults, including the ACTIVE study (described below), have incorporated elements of structure strategy training. West, Bagwell, and Dark-Freudeman (2008) employed a combined approach memory intervention for older adults including training in both organizational strategies and the "PQRST" mnemonic for remembering prose ("Preview" text, "Question" to identify the salient main ideas, "Read", "State" the major points, and "Test" memory). This intervention led to improvements in total prose recall which were maintained at least one month after training (West et al., 2008). Cognitive aging is characterized by stable, growing stores of acquired knowledge coupled with concurrent declines in processing resources (Horn, 1982; Salthouse, 1987; Baltes, 1997). Age-related declines or cross-sectional differences in prose memory are attenuated when the task permits the application of acquired knowledge (e.g., Dixon & Bäckman, 1993; Soederberg Miller, Stine-Morrow, Kirkorian, & Conroy, 2004), and when measurement emphasizes integration of prose information rather than verbatim reproduction (e.g., Dixon & Bäckman, 1993; Johnson, 2003). In fact, relative to younger adults, older adults excel in situations when story integration is required (Adams, 1991). These findings suggest that scoring approaches capturing older adults' relative strengths in integrating information (versus literal reproduction), and perhaps mnemonic strategies incorporating the application of acquired knowledge (for example, drawing on acquired knowledge to organize story information and identify salient ideas), may lead to improved prose memory performance in older adults.

The ACTIVE Study

The ACTIVE Study employed three cognitive interventions targeting memory, reasoning, and processing speed. The memory intervention represented a hybrid of the general mnemonic and prose-specific training approaches described earlier (Jobe et al., 2001). ACTIVE memory training mostly focused on general mnemonic strategies in remembering

word lists (three of the first five sessions focused on word list memory). General mnemonic training emphasized visualization, categorization, and mental associations as strategies to improve memory for each target in the list. Prose-specific training was taught in the fifth of ten sessions, and was practiced along with general mnemonics during the remaining five sessions. Prose training focused on structural organization of the story information into main ideas and details, on linking story information to prior knowledge, and emphasized remembering as much content as possible as opposed to verbatim recall.

Existing reports of ACTIVE memory training effects have combined prose recall measure with other measures of word list memory (Ball et al., 2002; Willis et al., 2006; but see Gross et al., 2012). Training-related improvement in memory performance was found compared to non-memory training groups and controls (Ball et al., 2002). Overall performance gains in memory specific to the memory-trained group were maintained up to 5 years after training (Willis et al., 2006). ACTIVE also employed two 4-session booster trainings to maintain training gains for the reasoning and speed-trained groups, but not for the memory-trained group (Willis et al., 2006). Neither the specific effects of training on prose recall, nor effects on the extent to which it was recalled verbatim or paraphrased, have been examined in previous reports of training effects for memory in ACTIVE. The present study extends that work by examining the memory training effect on prose recall, and by providing a detailed analysis of how the effect differs for procedural aspects of prose recall. Specifically, this analysis offers four points of innovation beyond previous papers: (a) disentangling prose recall from the memory composite and separate analysis of verbatim versus paraphrase recall; (b) examination of trajectory of prose recall at all ACTIVE occasions (i.e., baseline, posttest, and first-, second-, third- and fifth annual), only for a composite memory measure; (c) comparison of memory trained individuals not only to no-contact controls (as in previous publications) but to other training groups (i.e., “active controls”); and (d) comparison of booster training to both controls and un-boostered trained participants (only the latter comparison appeared in previous publications).

Because ACTIVE’s memory training for prose instructed participants to organize the story information, drawing on prior knowledge, and emphasized remembering as much information as possible regardless of the specific words used, we hypothesized that memory training would encourage participants to remember 1) more story information overall, and 2) more information in paraphrase rather than verbatim. We expected the amount of information remembered verbatim after training to remain stable, if not decline over time as older adult participants increasingly rely on paraphrasing the story information. This paper extends existing findings from ACTIVE by addressing whether an intervention and scoring approach emphasizing older adults’ strengths in story integration, drawn on acquired knowledge, facilitates improved memory for prose. Specifically, we examined whether the combination of general mnemonic and prose-specific training led to better verbatim and paraphrase recall, and whether training effects are durable over a period of up to 5 years of study observation.

Method

Participants

Community-living older adults ($N=1,912$) with available paper records for the Rivermead Behavioral Memory Test were used. We needed original paper records so that participants’ actual written responses could be coded idea by idea because the parent trial entered only the global recall score for the Rivermead measure in this analysis. Participants in the analytical sample ranged in age from 65 to 91 years, with a mean age of 72.9 ($SD=5.4$). Mean education was 13.2 years ($SD=2.6$) and ranged from 4 to 20 years; mean MMSE score was 27.3 ($SD=2.0$) and ranged from 23 to 30. The sample was 76% female and 72% White.

Compared to participants from the parent ACTIVE sample not included in this analysis, participants in our sample were younger (mean difference=2.3 years, $p < 0.05$), and less educated (mean difference=0.8 years, $p < 0.05$). There was no difference by sex. All data were collected in compliance with institutional standards for human research, and in accordance with the Helsinki Declaration.

Design

The ACTIVE study was a randomized controlled, single-blind trial described in detail elsewhere (Jobe et al., 2001). It evaluated whether one of three cognitive training interventions could improve the mental abilities and daily functioning of healthy older adults, and whether training-related gains were maintained in the long term. Participants were assessed at baseline, immediately after training (post-test), and annually at 1, 2, 3, 5, and 10-years after training (10th-annual testing data was not available at the time of the present study). Each intervention arm consisted of 10 small-group, 60–75 minute training sessions spread over 5–6 weeks targeting memory, reasoning, or cognitive processing speed.

At 11 and 35 months after training, 60% of participants who had attended at least 8 of 10 baseline training sessions (89.1% of trained participants) were randomly selected to be invited back for booster training. Booster training consisted of four 75-minutes sessions over a 3-week period designed to help participants maintain gains from the initial training. Booster sessions were similar in content and structure to the primary training sessions. We evaluated the effect of memory training on the trajectory of each outcome described below by comparing 1) participants who completed the initial memory training, 2) participants who both completed initial memory training and returned for booster memory training, and 3) participants who did not receive memory training (i.e., the control group, and the booster and non-booster training participants from the reasoning and speed intervention groups).

Training

ACTIVE memory training included both general mnemonic strategy training as well as specific instruction in strategies helpful for prose learning. With regard to general mnemonic training, instruction focused on multiple strategies in the context of four basic memory principles (meaningfulness, organization, visualization, and association). Strategies were practiced extensively in individual and group exercises, and on both laboratory-like tasks and tasks relevant to daily life. Participants received individual and group feedback on performance, a practice test, and self-efficacy enhancement.

The prose-recall training included instruction on paragraph organization according to main points and details. Memory for overall content was emphasized more than individual words. Subsequent exercises focused on parsing paragraphs to rank more and less important details, then using this information to diagram paragraphs into a hierarchical structure (Dixon et al., 2004). Participants were provided with a list of organizational questions (What is the main point? What are the major subplots? What are the minor details? Is the paragraph organized in order of importance?) to rehearse when provided with stories to recall. A subsequent exercise asked them to concentrate on identifying details when a story was heard. Finally, a generic approach was provided for printed stories that involved repeated readings, active engagement in association, visualization, and paraphrasing strategies, as well as underlining of main ideas. Participants were instructed to engage in deeper elaborative processing (e.g., ask what is happening, why it is happening, what might happen) where possible. Participants practiced these skills with the help of a trained facilitator during subsequent training sessions after learning them.

Measures

Story memory was assessed using the Rivermead Paragraph Recall test, a subtest of the Rivermead Behavioral Memory Test, version 2 (RBMT-2; Wilson, Cockburn, & Baddeley, 1991). Alternate passages were administered at different assessments. The alternate forms of the RBMT-2 are reported to be reliable (reliability = 0.78–0.85; Wilson, Cockburn, Baddeley, & Hiorns, 1989). Validity of the RBMT-2 has also been evaluated (Wilson et al., 1989), and convergent validity has been demonstrated with other standardized verbal memory tasks (e.g., Recognition Memory Test for words; Warrington, 1984; $r = 0.63$), as well as divergent validity with semantic processing tasks not related to everyday memory complaints ($r = 0.20$). Memory impaired patients' performance on the RBMT was also negatively correlated with rehabilitation therapists' observations of memory lapses ($r = -0.75$; Wilson et al., 1989). RBMT total baseline scores in the ACTIVE study were moderately correlated with baseline scores for the other memory measures (Table 1).

The RBMT was administered in small groups of 2–4 participants. Participants listened to a story on audiotape recorded by a professional narrator at a comfortable, slow-normal pace, holding speech rate constant, and were asked to write down everything they could remember immediately after the story was finished.

Scoring

Each Rivermead story contained between 54 and 65 words. Each story consisted of 21 idea units or individual lexical items, which we used for scoring story recall. Participants were scored on the quality of their recall of each idea unit (0 = not recalled; 0.5 = approximately accurate; 1 = completely accurate). The sum of these for each person at each occasion provided the Rivermead raw total recall score. Verbatim recall was computed as the percentage of idea units recalled completely accurately (proportion of idea units with 1 point), out of the 21 idea units possible. Similarly, paraphrase recall was computed as the number of idea units recalled for a score of 0.5 out of the 21 idea units possible. The sample sentence below provides an illustration that is consistent with, but not taken from, the Rivermead test.

Ms. Virginia / Boone / a mother of two / won / the mother of the year award / on Sunday / during a community celebration / in Chicago.

The Rivermead Paragraph forms used in ACTIVE were parallel but nonequivalent, making it difficult to clearly estimate within-person temporal trends. To equate tests used at different assessment occasions, we placed the alternate forms on an equivalent metric by converting the scores at each occasion to a T-score metric (Mean = 50, SD = 10 at each occasion) using the control group's mean and standard deviation at that occasion. Thus, the data from the four study groups (Memory, Reasoning, Speed, Control) were then separately standardized at each occasion, using the mean and standard deviation of the control group at that occasion as the standardization base. Thus, each intervention group's performance at each occasion was scaled relative to the control group, which was scaled to have a mean = 50, SD = 10. For example, if the mean of the memory group at a particular occasion was 55, this meant that the memory group performed 0.5 SDs higher than the control group at that occasion. Thus, at any occasion, intervention group differences from controls were preserved, but occasion-to-occasion variation was removed by this standardization approach. Although this standardization came at the cost of eliminating retest effects, it equated alternate forms of the measure while retaining sensitivity to intervention group differences in performance at each occasion. Concretely, if an intervention group gained more than the control group at any occasion, it would have a higher mean at that occasion. Analysis of the control group raw scores revealed that prior to standardization, there was no significant mean occasion-to-

occasion variation (i.e., practice effects or other temporal effects) in this dataset ($F(1,330) = 0.37, p = 0.54$).

Analysis plan

To evaluate the effects of the ACTIVE memory training on recall, two repeated measures, mixed effects models were fit (Cnaan, Laird, & Slasor, 1997). Model 1 assessed the effect of testing occasion and intervention group on total recall. Model 2 evaluated the interaction of recall type (verbatim, paraphrase) with intervention group and occasion. Univariate follow-up analyses for verbatim and paraphrase recall were conducted in Models 2a and 2b. A summary of the elements of Models 1 and 2 are available in a technical appendix. Independent indicator variables in models included fixed effects for each of the six testing occasions and for three groups: initial memory training only, booster + initial memory training, and not memory trained. Prose recall was initially examined separately for all of the ACTIVE groups, but because the patterns of recall over time were similar for all non-memory-training groups (i.e., Reasoning, Speed, Control), these were combined into one Non-Memory Training/No Training Control group for all analyses. All independent variables were estimated as class variables. Models 1 and 2 also included two covariates and their interaction (site, replicate, and site by replicate).

A random intercept (variance components error structure) was estimated in all models. Occasion was coded as a class variable with the baseline occasion as the reference category because temporal spacing was uneven and different intervention events (e.g., booster) occurred at various occasions. Different models had different outcomes, so nested model tests (i.e., likelihood ratio tests, AIC, BIC) were not used. Bonferroni-corrected pairwise comparisons were used to facilitate a simple effects decomposition of significant interactions; specifically, intervention group differences were examined separately at each occasion of measurement for total, verbatim and paraphrase recall. Power sensitivity analyses (G-Power 3; Erdfelder, Faul, & Buchner, 1996) suggested that with sample sizes like the one in this analysis, using a Bonferroni corrected alpha of 0.025 and a power of 0.8, the present design was able to detect effect sizes as low as Cohen's $d = .21$, which corresponds to a weak effect size.

Results

Total Recall

Model 1 (Table 1) assessed effects of group and occasion on the RBMT total recall score. There were main effects of occasion ($F(5,6837.43)=19.66, p<0.001$) and group ($F(2,1863.77)=7.16, p=0.001$) and a group-by-occasion interaction ($F(10,6834.53)=6.65, p<0.001$; Table 2, Figure 1). The group-by-occasion interaction was decomposed using Bonferroni-corrected follow-up comparisons, which revealed no baseline differences between the intervention groups. At post-test, both the booster-memory-trained group ($p<0.001$, mean difference=3.7, $t(1525)=5.08, d=0.34$) and the non-booster-memory-trained group ($p=.01$, mean difference=2.09, $t(1454)=2.45, d=0.19$) outperformed the non-memory-trained groups, but did not differ from each other. At the 1st annual follow-up, the booster-memory-trained group performed better than the control group ($p<0.001$, mean difference=3.36, $t(1260)=4.33, d=0.32$), but was comparable to the memory trained group that did not receive booster training. At the 2nd annual follow-up, no groups differed on total recall score. At the 3rd annual visit the booster memory-trained group again outperformed the non-memory trained group ($p<0.001$, mean difference=3.50, $t(1091)=4.19, d=0.35$) but did not differ from the non-booster-memory-trained group. At the 5th annual visit, mean performance in all groups was similar ($p>0.05$).

Verbatim and Paraphrase Recall

Model 2 examined whether the group-by-occasion interaction differed for recall type (Table 1). This model permitted us to assess whether any training group gained disproportionately more than controls at a particular occasion for verbatim and paraphrase recall. As above, the model design also included main effects of occasion and group. There were significant effects of occasion ($F(5,15897.91)=8.8, p<0.001$), group ($F(2,1860.35)=5.93, p=0.003$), and recall type ($F(1,15300.21)=58.13, p<0.001$). Importantly, the model also revealed a significant three-way (group-by-occasion-by-recall type) interaction ($F(10, 15300.21)=2.51, p=0.005$; Table 2, Figure 2). Bonferroni-corrected post hoc comparisons for each recall type at each occasion showed that for verbatim recall, the groups did not differ at baseline. At post-test, both the non-booster-memory-trained group (mean difference=2.15, $t(1454)=2.61, p=0.009, d=0.21$) and the booster-memory-trained group (mean difference=3.72, $t(1525)=5.20, p<0.001, d=0.35$) outperformed the non-memory-trained group, but did not differ from each other. At the 1st-annual follow-up occasion, the booster-trained memory group outperformed the non-memory trained group (mean difference= 2.95, $t(1260)=3.83, p<0.001, d=0.28$), and did so again at the 3rd-annual follow-up (mean difference= 3.85, $t(1091)=4.59, p<0.001, d=0.38$). At the 2nd- and 5th-annual occasions the groups did not differ.

For paraphrase recall, the groups differed at only one occasion: the booster-memory trained group performed better than the non-memory-trained group at the 1st annual follow-up (mean difference= 2.36, $t(1260)=2.99, p<0.001, d=0.22$; Table 2, Figure 3). There were no group differences in paraphrase recall at any other occasion. Paraphrase and verbatim scores were examined for ceiling and floor effects: no participant scored at ceiling for either type of recall, 2% scored at floor for verbatim recall, and 9% at floor for paraphrase recall.

As a follow-up sensitivity analysis, the same models were run comparing only the memory with booster, memory non-booster, and no-contact control groups (i.e., the “active control” reasoning- and speed-trained groups were excluded). These analyses yielded a near identical pattern of results, even at the level of identical pairwise comparison patterns between the groups at each occasion.

Discussion

The current investigation evaluated the effects of ACTIVE memory training on prose recall. The study investigated 1) whether prose memory improves following training, 2) how verbatim versus paraphrase recall may be influenced following training, and 3) to what extent the memory-trained groups maintained disproportionate advantages over the non-memory-trained groups over time. The study found that those who received memory training performed better than the non-memory trained group on total prose recall at testing occasions immediately preceded by training (i.e., post-test for the full memory-trained group, 1st and 3rd-annual followup occasions for the booster-trained group). However, memory group performance advantages did not persist beyond the immediate post-training periods.

With respect to recall type, the pattern of training effects differed for verbatim and paraphrase recall. Contrary to the hypothesized effects of training, analyses by recall type showed that training was associated with differences in paraphrase recall only at the 1st-annual follow-up occasion, for booster-trained memory group participants only. Paraphrase recall did not differ for any other groups at any other occasion. On the other hand, better verbatim recall was observed for the memory-trained relative to non-memory-trained participants at the post-test occasion, and better verbatim recall was also observed for those who received booster memory training at 1st- and 3rd-annual testing occasions (i.e., the

occasions at which booster training was received). No group differences were observed for the occasions at which booster training was not offered.

Although we hypothesized that ACTIVE's prose memory training would have encouraged participants to focus on remembering content, regardless of wording, the results demonstrate that training-related improvements occurred more for verbatim than for paraphrase recall. This pattern of results suggests that even though the prose training emphasized paraphrasing over verbatim memory, memory-trained participants still tended to remember more of the stories verbatim, rather than more in paraphrase, compared to participants who did not receive memory training. One explanation for this may be that because mnemonic strategies for word lists (which can only be remembered verbatim) were the primary focus of training; the first four sessions of training targeted these memory measures. A primary focus on prose recall occurred only during the fifth training session, and only the prose-memory specific training focused on paraphrase memory. Therefore, it may be that during prose recall testing, participants were influenced not only by the one session of prose memory strategy instruction they received, but also by the general mnemonic training they received throughout the preceding four sessions of the intervention. It is plausible that, during testing, participants may have put to use many or all of the mnemonic strategies they learned during training, without restricting their strategy selection to the task on which the strategy had initially been taught.

The prose memory strategy was the last mnemonic strategy introduced during ACTIVE training. It was taught in session 5 out of 10 total sessions. Sessions 1–4 introduced various general mnemonics applied toward memory for word lists, and sessions 6–10 focused on rehearsal of all mnemonic strategies taught. Participants may have devoted more time and effort toward the general mnemonic strategies than the prose memory strategy, given the earlier and overall greater allocation of attention to general mnemonics during the training sessions. Given the emphasis of the first four sessions on strategies to improve memory for word lists – in other words, to improve verbatim memory for specific words – if participants did devote more effort toward these strategies -- that may explain the greater training-related gains in verbatim recall. It may also help to explain the lack of maintenance for prose recall training effects, unless booster training was provided, over the follow-up testing occasions.

The results showed that training-related advantages for prose memory can be observed immediately after intervention (either the initial or booster training), but that at later testing occasions, training effects do not persist. This temporal specificity seems to suggest that – somewhat like physical exercise – cognitive training does not confer lasting beneficial effects with periodic brief administrations, but may require sustained, continuous practice for lasting improvements to be observed. Previous memory training studies (e.g., Anschutz et al, 1987; Scogin & Bienias, 1988) have reported a similar lack of durability of effects.

This study has several limitations. The results suggest participants may have prioritized verbatim over paraphrase recall during testing despite instructions to do the opposite. We were unable to corroborate this and other findings with participants' report on strategy use following testing. However, these data were not collected in ACTIVE. Second, interpretation of the results is also somewhat challenging, because evaluation of the intervention effects is limited to group comparisons at each occasion rather than comparisons of group trajectory over occasions. This approach to interpreting training effects was necessary because of the small but significant nonequivalence in difficulty among forms, for which the T-score standardization was used to equate forms. This standardization also had the effect of removing retest effects, allowing the relative training effect at each occasion to be observed. A final limitation is that we did not equate different versions of the RBMT at the item level using item response theory equating (Lord, 1953).

However, item response theory is infeasible in our setting because it requires story elements (i.e., items) that are shared in common across story lists, and this is not a feature of the RBMT's design.

This investigation based on the ACTIVE intervention trial demonstrated better overall prose memory for those who participated in memory training, with training-related advantages observed shortly after training, but which did not persist over one year. Specific training effects for paraphrase were observed only after the 1st annual follow-up training for the booster-memory trained group alone. Greater verbatim recall was observed for both memory trained groups at the post-test follow-up occasions, and for the booster memory-trained group at the occasions immediately preceded by booster training (i.e., the 1st and 3rd annual testing occasions). These results demonstrate that the ACTIVE memory training most improved verbatim memory for prose; however these training-related gains were not maintained without intermittent booster training.

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Figure 1.
Total recall T-scores by training group across occasions.

Figure 2.
Verbatim recall T-scores by training group across occasions.

Figure 3.
Paraphrase recall T-scores by training group across occasions.

Table 1

Correlation of the Rivermead (RBMT) verbatim and paraphrase baseline scores with total baseline scores of the other measures (Hopkins Verbal Learning Test (HVLТ), Brandt, 1991; Auditory Verbal Learning Test (AVLT), Rey, 1941) included in the ACTIVE memory composite.

	HVLТ Total Recall	AVLT Total Recall	RBMT Verbatim Recall	RBMB Paraphrase Recall
HVLТ Total Recall	1	.67*	.43*	.05*
AVLT Total Recall	-	1	.48*	.08*
RBMT Verbatim Recall	-		1	-.17*
RBMB Paraphrase Recall	-	-	-	1

* $p < 0.01$.

Table 2

Mean (SD) recall T-score by testing occasion, intervention group, and recall type.

	Baseline N=1912	Post-Test N=1695	1st Annual N=1419	2nd Annual N=1327	3rd Annual N=1222	5th Annual N=1052
Total Recall						
No Memory Training	50.41 (10.16)	50.44 (10.20)	50.54 (9.88)	50.27 (10.13)	50.63 (9.97)	50.21 (9.47)
Initial Memory Training	49.89 (10.08)	52.54 (11.35)	51.92 (10.43)	50.80 (10.21)	52.12 (10.43)	50.30 (9.32)
Booster + Initial Memory Training	50.34 (10.73)	54.15 (11.63)	53.90 (10.98)	52.04 (10.83)	54.14 (10.29)	51.17 (9.58)
Verbatim Recall						
No Memory Training	50.41 (10.12)	50.51 (10.06)	50.54 (9.78)	50.50 (10.20)	50.46 (10.02)	50.06 (9.75)
Initial Memory Training	50.10 (9.72)	52.66 (10.68)	52.00 (10.07)	51.20 (10.28)	51.93 (10.63)	49.95 (9.71)
Booster + Initial Memory Training	50.97 (10.12)	54.23 (11.16)	53.49 (10.95)	52.10 (11.00)	54.31 (10.24)	50.78 (9.96)
Paraphrase Recall						
No Memory Training	49.52 (10.07)	49.65 (9.76)	50.37 (10.06)	49.34 (10.24)	50.50 (10.17)	49.93 (10.28)
Initial Memory Training	50.33 (10.10)	49.94 (9.99)	50.67 (10.53)	48.89 (10.04)	50.50 (9.67)	49.69 (9.85)
Booster + Initial Memory Training	48.20 (9.48)	49.22 (9.40)	52.72 (11.14)	50.23 (11.06)	49.27 (11.07)	50.23 (9.55)