

Who would benefit from memory training? A pilot study examining the ceiling effect of concurrent cognitive stimulation

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Abstract: Diverse effects of memory training were observed in the literature. One possible factor is the amount of concurrent cognitive training received during the training program. In this pilot study, we recruited 24 elderly adults with or without concurrent cognitive stimulations to attend a memory-training program. Findings suggested that elderly people without concurrent cognitive stimulation could benefit from a memory-training program in the form of improved initiation and memory functioning. Self-rated quality of life measure also showed improvements alongside the cognitive benefits. Elderly people with regular concurrent cognitive stimulation, on the other hand, seemed to plateau in their level of performance and did not show any significant change. Our preliminary findings suggested nonlinear concurrent cognitive stimulation in the elderly.

Keywords: memory training, cognitive training, dementia, Chinese, elderly

Introduction

Memory training is one of the most common non-drug-training modalities employed to act against Alzheimer's disease or dementia (AD), or mild cognitive impairment (MCI).¹ Findings regarding the effect of memory training were diverse. In one study, patients with mild and mild-to-moderate AD demonstrated significant improvements in activities of daily living (ADL) under an individualized procedural memory training for four months.² In an evaluation study examining the effectiveness of four different interventions, an eight-week cognitive stimulation program significantly improved delayed memory performance in a group of demented elderly adults recruited from the community.³ Similar positive findings were observed in a randomized controlled trial examining the effectiveness of an eight-week memory training group.⁴ On the other hand, a study showed that elderly people who suffered from MCI had improved confidence in their memory functioning after a six-week memory skills training, but no significant difference in actual memory performance was observed between the treatment group and the control group.⁵ In a randomized placebo-controlled trial examining the effect of memory training, findings suggested that a six-week training on categorization and visualization techniques failed to improve memory functioning in a group of probable AD patients.⁶ No significant difference between the intervention and control groups was observed in a study with a group of dementia patients and their family caregivers who attended an intervention program comprising memory training and music therapy weekly for two years.⁷

With such diverse findings, are there any factors governing the success of one particular intervention regime? One potential factor is the degree of concurrent training participants received outside the study. Apart from the training provided dur-

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ing individual studies, the amount of concurrent cognitive stimulation was usually not reported or even not controlled in previous studies. As there is a possibility that a high level of concurrent training may have already brought participants to the ceiling of their training potential, its effect should be subjected to empirical evaluation. In the current study, we report the findings of a pilot study comparing the effect of memory training in two different groups of participants, one group with a minimum amount of concurrent cognitive stimulation while the other group receives continuous training on general cognitive skills. To our knowledge this is the first study that empirically investigates the influence of concurrent training on the effectiveness of a memory-training program. We hypothesize that without concurrent training, participants would benefit more from memory training when compared to those with concurrent training.

Materials and methods

Participants and demographics

Twenty-four elderly Chinese people with significant memory complaints (2 men, 22 women) volunteered to participate in this study. Fifteen of them were service users of two community recreational centers for the elderly (CRC group). The remaining 9 elderly adults were service users of a day training center for people with MCI or dementia (TC group). Baseline demographics are summarized in Table 1. Elderly from both groups had similar demographic parameters at the point of enrolment. No significant difference in age, educational level, or living companion was observed. General cognitive status screened with Mini Mental State Examination showed no difference between these two groups of people ($P > 0.05$). The CRC group reported significantly higher levels of memory complaints than the TC group, as measured by an abbreviated memory inventory for Chinese (score range: 0–5; CRC group = 4.02 ± 1.12 (range: 3–5), TC group = 2.30 ± 1.42 (range: 2–5), $P < 0.01$).

Study design

This is a prospective longitudinal study to investigate the effectiveness of memory training in elderly with or without concurrent cognitive stimulation. Prior to the memory-training program, elderly in both groups received different levels of trainings through their respective centers. The TC group received continuous cognitive stimulation activities (see Table 2) for at least three days per week, but the CRC group only participated in social and recreational activities. The continuous cognitive stimulation activities included eight sessions. “ADL training” introduced some daily self-care activities and techniques, including but not limited

Table 1 Demographics and baseline measures

Variables	Group		P value
	CRC N = 15	TC N = 9	
Age (Mean \pm SD)	77.63 \pm 5.91 (67–88)	78.33 \pm 5.59 (69–83)	0.363 ^a
Education level, N (%)			0.288 ^b
– No formal education	8 (53.3)	1 (11.1)	
– Primary education	6 (40.0)	4 (44.4)	
– Secondary education	1 (6.7)	2 (22.2)	
– University or above	0 (0.0)	2 (22.2)	
Living companion, N (%)			0.633 ^b
– With spouse	2 (13.3)	1 (11.1)	
– With siblings	5 (33.3)	5 (55.6)	
– Alone with helpers	1 (6.7)	1 (11.1)	
– Alone	7 (46.7)	2 (22.2)	
CMMSE (Mean \pm SD)	24.53 \pm 1.92 (23–28)	25.77 \pm 3.08 (21–30)	0.169 ^a
CDRS (Mean \pm SD)	119.53 \pm 13.01 (93–135)	120.65 \pm 7.96 (78–134)	0.765 ^a

Notes: ^aStudent's *t*-test; ^bChi-square test.

Abbreviations: CDRS, Chinese version of Mattis Dementia Rating Scale; CMMSE, Chinese version of the Mini-mental State Examination; CRC, Community Recreational Center group; PWI, The Personal Well-being Index; SD, Standard deviation; TC, Training Center group.

to personal hygiene, grooming, dressing and undressing, and feeding. “Physiotherapy” classes, eg, pain release, muscle strengthening, walking gait and balancing training, targeted an increase in muscle strength and body coordination to decrease the chance of falls. “Reality orientation” tried to increase self-confidence and self-motivation for the elderly to stay active by providing information through the concepts of time, place, and people. “Reminiscence therapy” involved the exchange of memories, information, wisdom, and skills among the elderly, their caregivers, and health professionals. This activity gave the elderly a sense of value, importance, belonging, power, and peace. “Multisensory stimulation” exposed the elderly to a stimulating environment delivering lighting effects, color, sounds, music, scents, taste, and tactile experiences to stimulate various senses. Such stimulation aimed to increase their concentration and it was hoped that this would relieve their behavioral

Table 2 List of modalities in the concurrent cognitive stimulation program received by the TC group

Core treatment modules of the day training center (TC Group)
• Activities of daily living (ADL) training
• Physiotherapy
• Reality orientation
• Reminiscence therapy
• Multisensory stimulation
• Music therapy
• Pet therapy
• Aroma therapy

problems. “Music therapy” used music as the primary media to help participants express themselves and release their emotions. “Pet therapy” was designed to improve the physical, social, emotional, and/or cognitive functioning of the elderly through interactions between the “comfort animals” and the participants. “Aroma therapy” combined with massage practices, was designed to relieve their anxieties and provide comfort to the elderly by personal direct contact in a relaxing setting. All participants still received their respective activities throughout the study period. Pre- and post-assessments were conducted before and right after the memory training program to evaluate the effectiveness. The assessments included the Chinese version of the Mini-Mental State Examination (CMMSE), the Chinese version of Mattis Dementia Rating Scale (CDRS), and the Personal Well-being Index (PWI), which will be described later. Informed consent was obtained from all participants. This study was approved by the research ethics committee of the Chinese University of Hong Kong.

Memory-training program

This is an eight-session group memory-training program administered by an occupational therapist following standardized training protocol. The program was provided to all 24 participants. One session was conducted twice a week at their respective daycare centers. The structure of the training program was based on the ACTIVE trial supplemented by previous reports of effective training, and the contents were adapted for Hong Kong Chinese elderly.^{3,4} An outline of the memory-training program is shown in Table 3. The “Education on memory deterioration and dementia” session introduced the process of normal aging, MCI, and dementia to the elderly. “Memory elements and memory games” taught the elderly to memorize and recall group members’ names by “face-recognition technique”. The card game (story-telling cards) and the interactive CD game (attention training exercise) were two key components of this session. “Memory exercises”

Table 3 List of the eight-session memory-training program provided to all participants

Topics of memory training
• Education on memory deterioration and dementia
• Memory elements and memory games
• Memory exercises
• Mnemonics 1
• Mnemonics 2
• Environmental awareness
• Lifestyle redesign
• Memory aids

included attention training on visual-spatial and auditory attention. The “Mnemonics 1” session aimed to teach the elderly to memorize things by categorizing and chunking functions. “Mnemonics 2” revised what was learnt in Mnemonics 1, and delivered techniques on memorizing things in terms of shopping places. “Environmental awareness” tried to orientate the elderly to places, people, and public transportation by visiting different communities in Hong Kong. The “Lifestyle redesign” session aimed to introduce a healthy diet and relaxation techniques in the elderly, and encouraged them to participate more in social activities and visit sharing groups. The 8th session, “Memory aids”, aimed to introduce smart living techniques, eg, effective use of a monthly scheduler and calendar, an alarm clock with larger font size, and the proper use of a phone book to record telephone numbers. Homework assignments were given after each memory training session.

Outcome measures

Cognitive functioning

General cognitive status was assessed using the CMMSE.⁸ The CMMSE was translated and validated by Chiu et al in the Hong Kong Chinese population.⁹ It is widely used in screening patients with general cognitive decline (sensitivity = 97.5 and specificity = 97.3, as validated from a study in Hong Kong).⁹

CDRS was also administered to provide a detailed profile of the participants’ level of cognitive functioning.¹⁰ CDRS examined five aspects of cognitive abilities, namely attention, initiation/perseveration, construction, conceptualization, and memory. Good psychometric properties were observed in both the original Mattis Dementia Rating Scale (DRS) and the Chinese translated version (Cronbach’s alpha = 0.84 and 0.89 respectively).^{11,12} Chan et al reported that a clinical cutoff score of 112 on the CDRS will give a sensitivity of 80.0 and a specificity of 91.6, providing good clinical utilities in the diagnosis of dementia.¹¹

Quality of life

The PWI was administered to assess participants’ subjective perceptions on their quality of life (QoL).¹³ The PWI was translated and validated in the Hong Kong population.¹⁴ Cross-cultural equivalence in the construct structure was established using factor analysis and the reported psychometric properties of the Chinese PWI was good (Cronbach’s alpha = 0.80).

Statistical analysis

Data analyses were carried out with Statistical Package for Social Sciences (SPSS; software package version 15,

IBM, Somers, NY). Student's *t*-test and Chi-square test were used to compare numeric and categorical variables in baseline measurements respectively. Two-way (training x group) repeated measures analysis of variance (ANOVA) was used to examine the changes in cognitive functioning and quality of life after memory training between the CRC and TC groups. Statistically significant difference was set at $P < 0.05$. Post hoc Bonferroni correction was used to correct any problems after multiple comparisons.

Results

Cognitive functioning

Marginally insignificant training x group interaction effect was observed in the CMMSE (see Table 4). A trend of slight decline in CMMSE score was observed in the TC group while the performance in the CRC group remained stable over training. No other effect was statistically significant or approaching significance. Using the more sensitive measure of cognitive functioning, that is, CDRS, significant main effect of group and significant training x group interaction effects were observed. Post-hoc analysis revealed a slight but statistically significant improvement in the CRC group's performance on the CDRS total score after training ($P < 0.05$) whereas the TC group's CDRS score remained at the same level ($P > 0.05$).

The CRC group had better performance on these subscales compared with the TC group generally. Further analysis on the CDRS subscale scores revealed significant interaction

effect on the initiation/perseveration subscale and marginally insignificant interaction effect on the memory subscale. Post-hoc analyses on the initiation/perseveration and memory subscales showed significant improvements of performance in the CRC group ($P < 0.05$), while the TC group's performance remained at a similar level ($P > 0.05$). Furthermore, significant main effects of group effects on the initiation/perseveration and memory subscales were observed.

Quality of life

Significant main effect of group and marginally insignificant training x group interaction effect were observed in the PWI. Elderly in the TC group on average had a statistically significant better QoL than the CRC group. However, post-hoc analysis showed that improvements in their PWI scores over the course of training in the CRC group was observed ($P < 0.05$), while the TC group maintained similar levels ($P > 0.05$).

Discussion

The current study takes an initial step to examine how concurrent cognitive stimulation affects the effectiveness of memory training. We hypothesized that elderly people without any concurrent cognitive stimulation may benefit more from memory training than elderly people with concurrent cognitive stimulation. The result of this study indicated that the experience of concurrent cognitive stimulation can affect the efficacy of this type of intervention.

Table 4 Results of the pre- and post-training assessment on participants' cognitive functioning and quality of life

Test	Group	Performance		ANOVA		
		Pre-training	Post-training	Group effect	Training effect	Group x training
CMMSE	CRC	24.53 (1.92)	25.07 (3.37)	F(1, 22) = 0.095, P = 0.760	F(1, 22) = 1.106, P = 0.304	F(1, 22) = 3.814, P = 0.064 ^b
	TC	25.33 (3.28)	23.56 (3.84)			
CDRS Total	CRC	119.53 (13.01)	124.60 (11.01)	F(1, 22) = 7.143, P = 0.014 ^a	F(1, 22) = 1.223, P = 0.281	F(1, 22) = 5.859, P = 0.024 ^a
	TC	108.22 (14.96)	106.33 (16.70)			
Attention	CRC	34.13 (2.42)	34.73 (1.71)	F(1, 22) = 1.788, P = 0.195	F(1, 22) = 0.207, P = 0.653	F(1, 22) = 0.982, P = 0.332
	TC	35.67 (1.87)	35.44 (2.88)			
Initiation/perseveration	CRC	27.53 (5.14)	30.06 (4.81)	F(1, 22) = 7.238, P = 0.013 ^a	F(1, 22) = 1.297, P = 0.267	F(1, 22) = 10.027, P = 0.004 ^a
	TC	24.00 (6.04)	22.56 (5.98)			
Construction	CRC	5.27 (1.28)	5.40 (1.35)	F(1, 22) = 0.503, P = 0.486	F(1, 22) = 1.027, P = 0.323	F(1, 22) = 0.064, P = 0.803
	TC	4.89 (1.05)	5.11 (0.78)			
Conceptualization	CRC	33.33 (4.86)	33.27 (4.17)	F(1, 22) = 3.620, P = 0.070 ^b	F(1, 22) = 0.002, P = 0.965	F(1, 22) = 0.002, P = 0.965
	TC	29.22 (6.63)	29.22 (6.65)			
Memory	CRC	19.27 (2.73)	20.6 (2.85)	F(1, 22) = 16.854, P < 0.01 ^a	F(1, 22) = 0.876, P = 0.359	F(1, 22) = 3.506, P = 0.075 ^b
	TC	14.44 (4.93)	14.00 (3.91)			
PWI	CRC	44.73 (11.95)	50.04 (9.39)	F(1, 22) = 7.471, P = 0.012 ^a	F(1, 22) = 0.027, P = 0.872	F(1, 22) = 4.140, P = 0.054 ^b
	TC	59.61 (8.91)	54.79 (10.31)			

Notes: ^aStatistically significant results, $P < 0.05$; ^bMarginally insignificant results, $P \leq 0.075$. Number of subjects: CRC = 15, TC = 9.

Abbreviations: ANOVA, analysis of variance; CDRS, Chinese version of Mattis Dementia Rating Scale; CMMSE, Chinese version of the Mini-mental State Examination; CRC, Community Recreational Center group; PWI, The Personal Well-being Index; TC, Training Center group.

Relatively few studies have investigated premorbid personal variables besides age, gender, educational level, and socioeconomic status in relation to the success of memory training. Existing studies could only conclude that concurrent involvement in complex cognitive activities is related to faster cognitive speed.¹⁵ Studies investigating the ceiling effects were limited to the outcome measures but not concurrent cognitive stimulation.¹⁶ As cognitive training has become more popular as a therapeutic and preventive nonpharmacological intervention for people with cognitive decline, the chance of aged people with related training recruited into clinical trials involving cognitive interventions will increase in the future. Researchers should be aware of the ceiling effect in data gathering.

Cognitive functioning

With memory training, participants in the CRC group showed a trend of improvement in general cognitive status, but not the TC group. The memory-training program in this study focused on enhancing selective cognitive functions of participants, including attention, registration, and recall, verbal fluency/word generation, perception, and problem solving. These components were not included in the concurrent cognitive stimulation received by the TC group. Both CRC and TC groups did not show any effect across the memory training. Contrasting the performance patterns of the CRC and TC groups across the training, we speculate that the training potential of the TC group for further improvement is relatively weak as compared to that of the CRC group, due to the ceiling effect as a result of concurrent training. Participants who received concurrent cognitive stimulation, therefore, may not benefit from additional memory training in general.

Closer examination of the CDRS subscale scores indicated that the efficacy was limited to the initiation/perseveration and memory subscales. Improvement on the initiation/perseveration subscale, as observed in the CRC group, may reveal important implications on the effect of the memory training. As the content of the memory training focused on skills improving memory ability, it is not surprising that improvement is reflected in the memory subscale. However, the cognitive ability examined by the initiation/perseveration subscale is more generalized and not specifically trained by the intervention program. Furthermore, if test-retest practice effect exists, both CRC and TC groups should have shown some improvements. In view of the differential patterns of changes in the total and subscale scores of CDRS between the CRC

and TC groups, retest-induced improvements should not be the best explanation for results obtained. As such, our findings reflected a true difference in the training potential among elderly with or without concurrent cognitive stimulating activities. The cognitive stimulation should not be assumed to be linear when other concurrent training is present. This nonlinear phenomenon is particularly important for researchers to consider in an attempt to evaluate the effectiveness of memory or other domains of cognitive training.

As concurrent cognitive stimulating activities can affect the efficacy of cognitive training, the effect of previous involvements in cognitive stimulation and cognitive training are also worth examining as most existing studies only exclude participants who were not currently enrolled in other research studies or clinical trials of cognitive training.¹⁷⁻¹⁹ Besides involvement in concurrent cognitive interventions, previous participation in the intervention group of other research may be another criteria researchers have to consider in the future.

Quality of life

Comparing the difference in the level of cognitive functioning in these two groups of elderly individuals, a similar trend of change in self-reported QoL after the memory training is also observed. The CRC group had statistically significant improvement in their PWI ratings whilst ratings by the TC group remained unchanged. One possible explanation for the change is that improvement in the CRC group's memory functioning has a positive impact on their ADLs. Improvements in memory functioning may enhance older people's self-confidence, resulting in an increase in their own rating of their QoL.⁵ An alternative explanation is that memory training acted as a placebo to the participants in the CRC group and enhanced their confidence in performing tasks. Participants in the TC group, on the other hand, attended routine training for at least 3 days a week. They have received adequate care continuously and thus the self-rated level of QoL may not change across the training. This speculation requires further studies for verification.

In conclusion, we have presented preliminary findings on the effect of concurrent cognitive stimulation on the training potential of the elderly population. Our data suggested that older people without concurrent training may benefit from a memory-training program more than those who receive continuous training. The factor of nonlinear concurrent cognitive stimulation should be considered in evaluating the effectiveness of memory training.

Limitations

The major limitation of this study is the small sample size to create a representative conclusion. This is a pilot study sharing the initial findings. A large-scale study following the pilot study with a large sample size based on similar settings is pending. Data generalizability is also an issue as a result of the small sample size although baseline information does not reflect this issue. The long-term effect of the concurrent memory program could be explored by assessing the participants after the training program, at perhaps 6 months.

Disclosure

No conflicts of interest were declared in relation to this paper.

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