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Integrative cognitive training for healthy elderly Chinese in community: A controlled study.

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Abstract

The short and long term effectiveness of integrative cognitive training for the healthy elderly in Chinese community was evaluated. Methods: Residents aged ≥70 years were enrolled from a subdistrict in Shanghai and 151 healthy residents who met the inclusion criteria were recruited into the present study whom were divided into cognitive intervention group (n=90) and control group (n=61). All individuals were assessed with the Neuropsychological Test Battery for Elderly (NTBE), stroop color-word test and a questionnaire "Shanghai Health Survey for the Elderly (VER2006)" at baseline, and immediately, half a year, one year after intervention. The interventions (include reasoning, memory, etc) were conducted for 24 sessions over 12 weeks. 1) Baseline: There were no significant differences in the neuropsychological scores between intervention group and control group except for the scores in two subscales. 2) Follow up: Functions in many subscales of NTBE and Stroop color-word test were significantly improved and those in the intervention group were higher than in control group immediately and one year after intervention. The integrative cognitive training can improve and /or delay the degeneration of cognitive function of the elderly in the community, and the effectiveness of cognitive training may last for at least one year, especially in the reasoning ability.

Keywords: Community mental health service; Aged; Cognition; Intervention; Neuropsychological test; Follow up

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Introduction

The population of old people is rising in the 21st century. In Shanghai, there are 14.12 million people in 2010, and people aged ≥ 60 years account for 23.4% of the total population [1].. Although the cognition has a declining tendency over age and some people may developed Alzheimer's disease at last, how to delay this process and raise the quality of life are still an important issue in the public health [2-4]. In recent years, the cognitive training has attracted increasing interest as a solution to such an age-related cognition decline in a lot of countries [5-9].

The Advanced Cognitive Training for Independent and Vital Elderly (ACTIVE) [5-13] study is the first multicenter, randomized, controlled trial to examine the long-term outcomes of cognitive function of older individuals receiving cognitive interventions. Results revealed each of 3 cognitive interventions (training for reasoning, memory, speed of processing) could improve the cognitive ability it targeted and these improvements were maintained through the 5 years of follow-up. After this team analyzed further MCI (mild cognitive impairment) in this sample, it was found that a positive effect was shown in both training for reasoning and speed of processing groups, while no significant change was observed in training for memory group. Shinya et al conducted training for reading and arithmetic in the community elderly, and the results confirmed that the daily brain training can improve the cognitive function of the elderly, not only improving the training-related specific domain of cognitive function, but also playing a positive role in the improvement of other cognitive domains [14]. Some subsequent studies also confirmed these findings [15-22].

In most of the studies, a single training method is used which may benefit the elaboration of mechanism of the improvement. However, it can't avoid some disadvantages that the interest and attending ratio of the elderly are reduced and the improvement in found in a few cognition areas. In the present study, the integrative cognitive training was conducted in the healthy community elderly, and the global improvement of the cognition was observed in order to confirm whether this method is feasible and effective to solve the social healthy problem in Chinese elderly.

Subjects and Methods

Participants

The cluster random sampling and screening was employed in the community elderly of a street of Shanghai by the unit of the community under the jurisdiction of the most basic neighborhood committee on April 2006 and a total of 347 elderly people were screened. This study has obtained the consent of the Ethics Committee of Tongji Hospital of Tongji University. All participants signed an informed consent form.

Inclusion criteria

1) Over 70 years. 2) No body disability and serious physical diseases, with the ability of living on their own. 3) No mental disorder. 4) Non-illiterate (including literacy classes), no serious decline in vision and hearing (due to listening, speaking, reading and writing involved in the intervention).

Grouping

151 community elderly met the inclusion criteria, including 83 males and 68 females (age: 74.8±3.7 (70～89) years).They were given the intervention and non-intervention informed consent conversation at a sequencing interval (50 elderly people as a unit) and were divided into the intervention group (n=90) and the control group (n=61). In the intervention group (53 men and 37 women), the mean years of education were 9.4±3.9 years and the mean age was 74.7±3.7 years. In the control group (30 men, 31 women), the mean years of education were 9.2±4.0 years and the mean age was 75.0±3.8 years. There were no marked differences in the mean years of education and mean age between two groups. Examination was performed at immediately, half a year and one year after intervention when there were 83, 77 and 73 subjects, respectively in the intervention group and 51, 47 and 45 subjects, respectively in the control group.

Sample Size

According to the formula n= (σ/Δ)2×(Zα/2+Zβ)2, we adopted the values (α=0.05 (type I error), Zα/2=1.96; β=0.1 (type II error), Zβ=1.65; σ represents the standard deviation, Δ represents the actual difference) and 30% of expulsion rate from the previous studies by the research group [23], in a ratio of 3:2 for the intervention group and the control group, finally it was obtained that the sample size of both groups were 90 and 60 cases, respectively.

Interventions

The interventions included memory training (memory for words, stories, faces, etc.), reasoning training (finding the pattern in the pictures and identifying the next item in the series), speed of processing (finding a road on a map in limited time), painting, calligraphy practice, handwork, etc. The interventions were conducted in small group settings over 12 weeks. Interventions were carried out by 2 graduate students of the department of psychiatry twice weekly for a total of 24 sessions and each lasted for 60 min. Subjects in the intervention group also completed the self-training exercises on their leisure time, such as reading, painting, writing, etc. Individuals in the control group had no training and no contact with those in the intervention group.

Measures

Assessments were conducted at baseline, immediately, half a year and 1 year after intervention by 4 assessors who were blinded to the study design. Cognitive outcomes were measured by using the Neuropsychological Test Battery for Elderly (NTBE), Stroop color-word test and a questionnaire “Shanghai Health Survey for the Elderly”.

NTBE [24-25]

The World Health Organization-Battery of Cognitive Assessment Instrument for Elderly of Chinese edition was used and included 59 items in 9 domains: (1) auditory verb learning; (2) sorting test; (3) cancellation test; (4) language test; (5) Moter test; (6) visuognosis test;(7)reasoning test; (8) visual-space test;(9)color trials.

Stroop color-word test

The Stroop Color-Word Test is considered to be a general measure of cognitive flexibility and executive functioning. Subjects were first asked to read the names of colors (subtask 1) and subsequently to name the color blocks (subtask 2).Then, participants were asked to name the words which were printed with color ink, rather than to read the color (subtask 3). Finally, participants were asked to name the color of the ink in which the words were printed, rather than to read the words (subtask 4) [26].

Shanghai Health Survey for the Elderly

It includes sociodemographic measures and a battery of standardized instruments, including the MMSE (CMMSE) of Chinese edition, the activities of daily living (ADL), the Short-Form 36-item health survey (SF-36), the personality indicators, and the Self-efficacy scale (SES) [27].

Data entry and statistical analysis

For the original data, the scientific coding was conducted by the statistical principle combined with the profession, Epidata 3.0 was adopted to establish a database and SPSS13.0 was used for checking, meanwhile, the descriptive statistical analysis and the chi-square test was used for the statistical analysis of the demographic data, t test was employed for the self-contrast of the intervention group and the control group before and after the interventions and the analysis of covariance was adopted for the test between the intervention group and the control group. Intension-to-treat analysis (ITT) method was used for the efficacy evaluation, and all the elderly who participated in more than one courses and can be followed up were included into the statistical analysis.

Results

NTBE

Baseline: Independent-samples t test was performed to compare the scores between two groups. There were no significant differences in the scores of neuropsychological tests between intervention group and control group except for the scores of two subscales of auditory verb learning ($P \le 0.05$).

Follow up: Paired-samples t test was used to compare the scores before and after interventions. Results showed functions in 12 subscales were significantly improved and those in 3 subscales markedly declined in the intervention group ($P \le 0.05$~0.01).In the control group, functions in 8 subscales were significantly improved and those in 2 subscales declined dramatically ($P \le 0.05$~0.01). Univariate general liner model was employed to compare the scores between groups after controlling the baseline cognitive function. Results showed functions in 4 subscales in the intervention group were better than in the control group after cognitive training ($P \le 0.05$~0.01) (Table 1). At half a year after cognitive training, the functions in 20 subscales were significantly improved and in 1 subscale declined in the intervention group ($P \le 0.05$~0.01). In the control group, functions in 14 subscales were markedly improved and in 1 subscale declined ($P \le 0.05$～0.01). Analysis showed functions in 2 subscales in the intervention group were better than in the control group ($P \le 0.05$~0.01) (Table 3). At 1 year after cognitive training, the functions in 19 subscales were significantly improved and in 4 subscales declined in the intervention group ($P \le 0.05$~0.01). In the control group, functions in the 11 subscales were remarkably improved and in 3 subscale declined ($P \le 0.05$~0.01). Analysis revealed functions in 3 subscales in the intervention group were better than in the control group ($P \le 0.05$~0.01) (Table 3).

Table 1. *Scores of NTBE at baseline and after interventions ($\bar{X}$ ±s). *P ≤0.05, **P≤0.01*

content	Intervention group (n=83)		Control group (n=51)		P		
	1)baseline	2) after intervention	3) baseline	4) after intervention	1) vs 2)	3) vs 4)	2)vs 4)
Right recall number in auditory verb learning 1	4.75±1.58	5.80±2.01	5.00±1.95	6.39±2.08	0.00**	0.00**	0.10
Right recall number in auditory verb learning 2	7.07±2.03	8.45±2.46	7.25±2.15	8.55±2.49	0.00**	0.00**	0.89
Right recall number in auditory verb learning 3	8.69±2.33	9.78±2.49	8.63±2.42	9.86±2.55	0.00**	0.00**	0.79
Unrelated insert number in auditory verb learning 3	0.17±0.38	0.43±0.90	0.33±0.68	0.18±0.43	0.02*	0.19	0.08
Right recall number in auditory verb learning 4	9.37±2.34	10.55±2.45	9.22±2.47	10.47±2.69	0.00**	0.00**	0.99
Right recall number in auditory verb learning 5	10.17±2.60	11.23±2.42	9.98±2.53	10.69±2.65	0.00**	0.04*	0.24
Unrelated insert l number in auditory verb learning 5	0.29±0.63	0.51±0.80	0.14±0.35	0.29±0.54	0.02*	0.06	0.23
Sorting test	9.35±0.93	9.66±0.67	9.53±0.95	9.51±0.88	0.00**	0.92	0.19
Error number of cancellation test of red circle	0.66±4.95	0.04±0.24	0.33±1.56	0.24±0.84	0.25	0.70	0.05*
Finished time in cancellation test of blue circle	43.11±14.34	46.60±15.94	40.69±16.49	41.78±9.96	0.04*	0.62	0.09
Name recall test	5.71±1.14	5.90±0.84	5.90±1.12	5.53±1.22	0.19	0.03*	0.01**
Mini-token test	2.41±0.99	2.67±0.93	2.29±1.04	2.43±0.94	0.02*	0.30	0.19
Moter test	23.80±4.77	25.87±2.21	24.35±3.01	25.08±4.46	0.00**	0.26	0.13
Semantic link test	3.25±0.97	3.28±0.87	2.67±1.13	3.06±0.93	0.83	0.05*	0.63
Reasoning test	5.00±2.03	5.99±1.93	4.73±1.63	4.96±2.01	0.00**	0.36	0.00**
Right recall of delayed recall 6	8.60±3.29	10.07±3.10	8.20±3.32	9.55±3.95	0.00**	0.01**	0.59

Right recall of delayed recall 8	7.58±3.54	9.04±3.78	7.61±3.42	9.20±3.77	0.00**	0.00**	0.78
Finished time in color trials 1(s)	126.05±61.33	111.80±46.83	121.14±58.39	112.35±54.93	0.00**	0.07	0.54
Error number in color trials 1	0.63±1.19	0.42±1.03	0.47±0.88	0.98±1.83	0.18	0.05*	0.01**

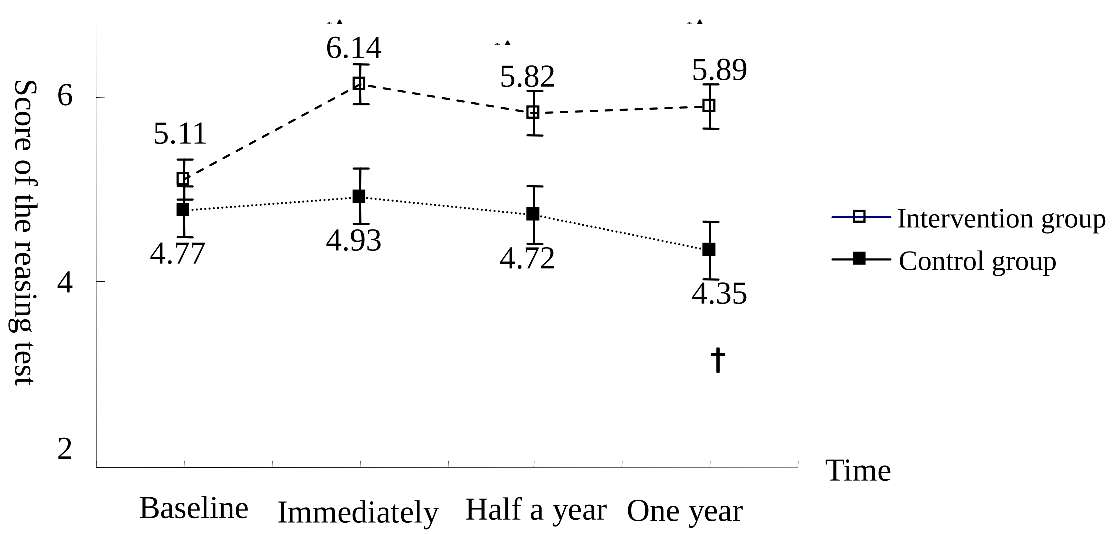

Figure 1.*Training Effects on reasoning test scores. *P≤0.01 vs baseline ▲P≤0.01 vs control group,† P≤0.05 vs immediately*

Table 2. *Scores of stroop color-word test at baseline and after interventions ($\overline{X}$ ±s). *P ≤0.05, **P≤0.01*

content	Intervention group(n=83)		Control group(n=51)		P		
	1)baseline	2)after intervention	3)baseline	4)after intervention	1)vs2)	3)vs4)	2)V4)
Time in subtask 1	32.87±10.49	30.51±7.27	32.65±7.62	31.02±6.74	0.01**	0.08	0.50
Correct number in subtask 1	49.59±1.16	49.88±0.33	49.41±1.19	49.75±0.66	0.03*	0.02*	0.18
Error number in subtask 1	0.34±0.85	0.08±0.28	0.49±1.16	0.24±0.65	0.01**	0.08	0.11
Immediately correct number in subtask 1	0.45±0.82	0.22±0.5	0.49±0.86	0.41±0.70	0.02*	0.60	0.07
Immediately correct number in subtask 2	1.24±1.38	0.81±0.98	1.33±1.45	1.10±1.20	0.01**	0.16	0.14
Time in subtask 3	52.78±19.47	53.28±20.33	49.82±20.09	54.57±17.46	0.79	0.01**	0.19
Missing number in subtask 4	0.07±0.30	0.01±0.11	0.06±0.42	0.14±0.53	0.10	0.42	0.04*
Repeated number in subtask 4	0.35±1.10	0.06±0.36	0.12±0.52	0.37±1.06	0.03*	0.14	0.02**
Color interfere time	19.92±16.45	22.77±17.31	17.18±16.13	23.55±14.65	0.14	0.00**	0.38

General liner model was run with repeated measures define factors, the reasoning improved immediately after interventions and the improvement maintained for at least 1 year. In the control group, the reasoning declined at 1 year after interventions (Figure 1).

Stroop color-word test

Baseline: There were no significant differences in the scores of subtests between intervention group and control group.

Follow up: Functions in 6 subscales were significantly improved in the intervention group (P≤0.05~0.01).In the control group, functions in 1 subscale were significantly improved and in 2 subscales declined (P≤0.05~0.01). Moreover, functions in 2 subscales in the intervention group were better than in the control group after cognitive training (P≤0.05~0.01) (Table 2). At half a year after cognitive training, functions in 3 subscales were significantly improved in the intervention group (P≤0.05~0.01). In the control group, functions in 2 subscales were significantly improved and in 1 subscale declined (P≤0.05~0.01) (Table 3). At 1 year after cognitive training, functions in 4 subscales were significantly improved and in 2 subscales declined in the intervention group (P≤0.05~0.01). In addition, functions in 4 subscales were significantly improved and in 2 subscales declined in the control group (P≤0.05~0.01) (Table 3).

Table 3. *Improved/declined number of NTBE and stroop color-word test in follow up*

Test		After intervention		Half a year		One year	
		Intervention group (n=83)	Control group (n=51)	Intervention group (n=77)	Control group (n=47)	Intervention group (n=73)	Control group (n=45)
NTBE	Improvement	12	8	20	14	19	11
	Decline	3	2	1	1	4	3
Stroop	Improvement	6	1	3	2	4	4
	Decline	0	2	0	1	2	2

Table 4. *Changes in the cognitive ability across time by group.↑improvement vs baseline,↓decline vs baseline,-- no change,+ improvement vs control group*

Cognitive ability	After intervention		Half a year		One year	
	Intervention group	Control group	Intervention group	Intervention group	Control group	Intervention group
immediate memory	↑	↑	↑	↑	↑	↑
delayed recall	↑	--	↑	↑	↑	--
study effect	+	--	↓	--	↓	↓
visual scan	↑+	--	↑	--	↑	↓
concept formation	↑	--	↑	--	↑	--
Attention	↑	--	↑	--	↑	↓
speech ability	↑	--	↑	--	↑	--
working memory	--	↓	--	--	--	--
Reasoning	↑+	--	↑+	--	↑+	--
visual-space analysis	--	--	↑	--	↑	--
perceptive motor speed	↑	↓	↑	↑	↑	↑
execute function	↑+	↓	↑	↓	--	--

Discussion

It is the first trail to apply the integrative cognitive training in the elderly in China. Although single intervention has been successfully used to improve the cognition in the elderly, the combined methods for interventions were applied to improve the cognition in the Chinese elderly and the primary outcome was measured within on year. Our previous study showed the subjects aged 70~75 years experienced the rapid decline in the cognition [28]. In the present study, subjects aged >70 years were recruited for analysis.

Overall, our study demonstrated that the integrative cognitive interventions helped the healthy community elderly to perform better on many cognitive abilities. Subjects in the intervention group performed better on the memory, study effect, visual scan, concept formation, attention, speech ability, reasoning, visual-space analysis and conbinition, perceptive motor speed, execute function after interventions, and most improvements in these domains lasted for at least one year (Table 4). However, in the control group, there was little improvement and some cognitive abilities, such as attention, study effect, visual scan, etc, declined significantly. In addition, some of the domains, such as immediate memory, were also improved in the control group which may be attributed to the high withdraw in this group and better performance in the remaining elderly with good cognition.

Improved cognitive function in the intervention group suggests the plasticity of human brain. It also confirmed the mechanism of successful aging which our study found previously that executive function may be an impressionable domain in the cognition of the elderly [29]. In the intervention group, the reasoning ability was improved and better than that in the control group, which lasted for at least one year. This also demonstrates the reasoning ability is a susceptible area to cognitive intervention in the healthy elderly. We may increase the reasoning lessons and for the emphasis in future.

NTBE reasoning test in the intervention group was the only item in which the three time points were improved significantly and were better than those of the intervention group after the interventions, indicating that the logical reasoning ability was the susceptible domain for cognitive intervention in the healthy elderly, and the reasoning ability had a room for improvement and maintained a long-term effectiveness, which may be associated with the relevant methods and skills mastered and the accurate strategies adopted by the elderly in learning. While it was reported that the effectiveness of the reasoning training can be up to seven years [30], therefore, the long-term effectiveness of the impact of the integrative cognitive training on reasoning ability needs to be further follow-up observation in future.

In the present study, the integrative cognitive training may cover a number of cognitive areas. Each of the strategies for training improved the target ability. Meanwhile it interacted with other aspects and increased other ability or compensated the declined ability. Thus, the global cognitive function was improved in the elderly and may helpful for the improvement of quality of life.

The items which were better in the intervention group than those in the control group decreased or the declined items increased at six months and one year after the end of the intervention (no difference between both through Stroop word-color interference test), illustrating the effectiveness of interventions decreased over time, so the enhanced interventions were arranged at one year in some foreign studies. The long-term effectiveness of the enhanced interventions group within two years and five years was superior to that of the non-enhanced intervention group, and the improvement in daily living ability in the former was also different from that of the latter [7-9]. In the future interventions, it was recommended that the enhanced intervention was conducted at six months after the end of interventions, and the enhanced interventions can be performed again at one year for the elderly who had the conditions for training to strengthen the training effect and reduce the recession of the intervention effects.

Conclusions

Integrative cognitive training is an effective cognitive intervention method, and it can improve or delay the cognition decline in the healthy elderly in the short term. A number of cognitive functions remain a valid trend one year after the end of interventions and the logical reasoning ability and others are the susceptible domain for cognitive intervention in healthy elderly.

Limitations

This study has several limitations. First, the participants in this study were adults aged >70 years. Thus, there is possibility that results might be influenced by the weather or other physical diseases or a variety of unknown reasons resulting in the increase of withdraw rate. Second, when compared with studies with large sample size, the number of subjects is small in the present study and the number of 2 groups was unbalanced, which may also impacted the findings. Finally, this study was carried out in Shanghai and the elderly had high education level and good health situation. Thus, whether the findings of our study are applicable for the elderly with low education level or severe diseases is still unknown.

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