SOUTHERN GERONTOLOGICAL SOCIETY

Journal of Applied Gerontology
2018, Vol. 37(10) 1195–1214

DOI: 10.1177/0733464816684622
journals.sagepub.com/home/jag
SAGE

The Effects of Integrated Attention Training for Older Chinese Adults With Subjective Cognitive Complaints: A Randomized Controlled Study

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Abstract

Objective: Early intervention to reduce cognitive decline and preserve functioning is a compelling public health issue. Because impaired attention occurs early in the process of cognitive impairment, focusing training strategies upon attention may be a potential intervention to prevent further cognitive decline. We sought to test the effects on cognitive performance and daily functioning of a new cognitive training program that focuses on attention. **Method:** This single-blind randomized controlled trial lasted 6 months and included two phases. Assessments were conducted at baseline, at 3 months, and at 6 months. The study was performed in four community

Manuscript received: February 14, 2016; **final revision received:** October 10, 2016; **accepted:** October 29, 2016.

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older adult centers. Ninety-three participants with subjective cognitive impairment without dementia were included. Forty-seven participants were randomized to the Integrated Attention Training Program (IATP), and 46 were randomized to the control group. The two arms of the study included the IATP (intervention group) and a health-related education program (active control group). **Results:** No significant interactions were identified between group and time for the Clinical Dementia Rating–Sum of Boxes and other secondary outcomes, except for the Digit Forward Score ($p < .05$; effect size, 0.057). When the preintervention and postintervention results were compared, the IATP group showed significant improvement in grand mean effect ($p < .05$) and accuracy ($p < .05$) in the Attention Network Test, Digit Backward Score ($p < .05$), Category Verbal Fluency Test ($p < .05$), and Trail Making Test A ($p < .01$) immediately after the intervention. These improvements were sustained 3 months after the intervention. **Conclusion:** The IATP showed domain-specific effects but had no effects on global cognition or functioning. It could not show a superior benefit in cognition and functioning when compared with non-specific mental stimulation in a group format. Further studies are needed to determine the role of attention in cognitive training.

Keywords
attention, cognitive training, cognitive impairment, dementia

Introduction

Age-related diseases, particularly dementia, are a great health burden in Hong Kong and worldwide. Interventions that aim to ameliorate cognitive decline or prevent dementia offer a compelling alternative paradigm for reducing the impact of the disease, not only on individuals but also on their families and on society.

In principle, to achieve its optimal benefits, intervention for dementia should begin at the earliest preclinical stage. However, no evidence has been found to support a pharmacological approach in the prevention, reduction, or postponement of cognitive decline during the pre-symptomatic phase (Raschetti, Albanese, Vanacore, & Maggini, 2007). In addition to pharmacological approaches, cognitive training (CT) is increasingly recognized as an important alternative means by which to tackle this problem.

A CT program involves structured training and practice on tasks that target specific cognitive domains such as memory, attention, language, and executive function (Clare, Woods, Moniz Cook, Orrell, & Spector, 2003). A growing body of evidence supports the effectiveness of CT on cognitive functions. The potential benefits of CT are achieved mainly by means of improvements in brain plasticity and cognitive reserve (Stern, 2002; Valenzuela & Sachdev, 2006).

However, most previous studies of CT focused mainly on the memory domain. The effects of training were usually domain specific and cannot be generalized to other cognitive domains or to daily functioning (Acevedo & Loewenstein, 2007; Ball et al., 2002; Kwok, Bai, Li, Ho, & Lee, 2013). Even though those trials showed promising results, the control subjects were often assigned to receive no contact or standard care instead of comparable psychosocial intervention. The non-cognitive factors that may contribute to better cognitive outcomes were not adequately studied or controlled (Valenzuela & Sachdev, 2009). According to a meta-analysis of the effects of CT, no sustained and generalizable benefit was seen in functional performance in cognitively impaired or healthy older adults when compared with active control conditions (Martin, Clare, Altgassen, Cameron, & Zehnder, 2011).

Attention is an important and fundamental component of cognitive function. Cross-sectional and longitudinal studies have suggested that attention is one of the non-memory cognitive domains that are impaired in the early stages of Alzheimer's disease (Posner & Petersen, 1990). Attention was categorized in the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; *DSM-5*; American Psychiatric Association [APA], 2013) into sustained, selective, and divided attention. Sustained attention is the ability to maintain attentional focus over time, selective attention is the ability to focus on a single relevant stimulus or process while ignoring irrelevant stimuli, and divided attention is the ability to distribute attention across multiple stimuli or processes and to identify more than one feature of stimuli or multiple stimuli. Each attentional function is coordinated by different parts of the brain and networks across the frontal, temporal, and parietal lobes. A relationship has been shown between divided attention deficit and functional decline and falls (Camicioli, Howieson, Lehman, & Kaye, 1997; Hauer, Marburger, & Oster, 2002; Hauer et al., 2003; Verghese et al., 2002).

Attention can be enhanced by various methods, including an awareness of breathing and the body parts commonly used in meditation and mindfulness training (Jha, Krompinger, & Baime, 2007; Kozasa et al., 2012; Tang et al., 2007). Divided attention has been shown to be improved by dual-task training, which requires participants to perform concurrent motor and cognitive tasks (Schwenk, Zieschang, Oster, & Hauer, 2010).

Few previous studies involved an attention component in the CT program. One of the largest CT studies—Advanced Cognitive Training for Independent and Vital Elderly (ACTIVE), involving more than 2,000 participants—showed that CT could improve the targeted cognitive abilities for a long period of time after intervention (Ball et al., 2002). Significant improvement was seen in the trained domains, including attention. However, although it involved an attention component, it was limited to processing speed. Other attention components, such as divided attention and selective attention, were not included. The training effect of particular cognitive domains also could not be transferred to other cognitive domains. Despite that, a recent study suggested that a CT program targeting attention could generalize the benefit to the non-trained cognitive domain (Mozolic, Long, Morgan, Rawley-Payne, & Laurienti, 2011).

In addition to the content, the practicability of programs delivered in a community setting is also important. Despite the growing numbers of CT programs in recent years, most require computers or specialized devices that may not be easily available in older adult centers or that could not be handled by local Chinese older adults.

Therefore, to address this important public health issue, we aimed to develop a simple and structured CT program focused on attention that could be effectively delivered in a community setting. We chose healthy older adults with subjective cognitive complaints but without dementia as the target group because subjective cognitive complaints are associated with underlying brain changes that might increase the risk of cognitive decline. These complaints may indicate a possible early neurodegenerative process that warrants further investigation and intervention (Stewart, 2012). Active control was used in this study to show any specific training effect of the current program other than a non-specific mental stimulation effect.

Objective

Our main objective was to develop a newly integrated CT program—the Integrated Attention Training Program (IATP)—suited to older adults in a community setting. This study was performed to explore the logistics, potential benefits, adverse events, and acceptability of this new training program. It was designed to compare the effects on cognitive performance and daily functioning in participants who were randomized to attend either the IATP or a health-related education program. It was hoped that the information gathered in this study would facilitate a further large-scale study on cognitive intervention for brain health and for the prevention of dementia. We hypothesized that the IATP group in this study would show results in cognitive performance and everyday functioning superior to those of the control group.

Method

Recruitment Centers and Participants

The participants were recruited by means of advertisements at four community older adult centers in Hong Kong between September 2012 and January 2013. Each participant underwent a 10- to 15-min interview with an eligibility assessment by the center's social worker according to the inclusion and exclusion criteria stated below before enrollment in the study. Assessment included determination of medical and psychiatric histories and demographic details. The baseline assessment was carried out by research assistants after the participants met the criteria of the study and signed the consent form.

The inclusion criteria were (a) an age of 60 years or above, (b) the presence of subjective cognitive complaints, and (c) the ability to communicate in Cantonese. The exclusion criteria were (a) a clinical diagnosis of dementia, according to the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM-IV*; APA, 1994); (b) a history of major psychiatric illness; (c) prescription of a psychotropic or other medication known to affect cognition (e.g., benzodiazepines, anti-dementia medication); (d) attendance at regular CT therapy or another intervention for brain health during the study period; (e) a history of major neurologic deficit, including stroke, transient ischemic attack, or traumatic brain injury; and (f) a significant communicative impairment.

Design

The details of the study design are explained in Figure 1. This study was a single-blind randomized controlled trial. The intervention phase and the monitoring phase each lasted 3 months. The first 3 months (the intervention phase) served as the core component of the study protocol. It involved attendance at either the IATP (intervention arm) or a health-related education program (active control arm). In each arm, the same research assistant administered the intervention to groups of six to eight participants. Attendance was tracked to monitor adherence.

The 3-month monitoring phase commenced immediately after the completion of the intervention phase. It was primarily designed for observation of the sustained effects of the training. Second, it served as a feasibility test of the IATP as a self-administered mental exercise at home. Every participant in the intervention group was given a practice manual to aid his or her home practice. A member of the research staff called the participants every 2 weeks to remind them about the continuation of the program and to keep track of adherence.

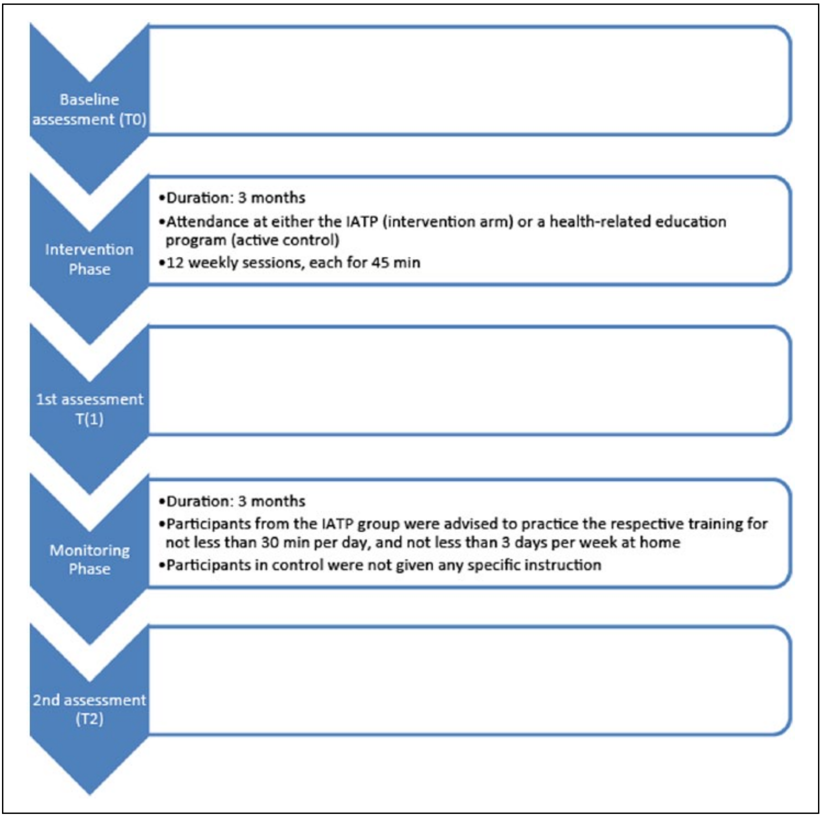

Figure 1. Design of current study.
Note. IATP = Integrated Attention Training Program.

Intervention

Integrated Attention Training Program (IATP). The IATP adopts a simple, practical, and integrated framework to enhance its acceptability and the sustained interest of the participants. The activities in this training program focus on the attention domain, including sustained, selective, and divided attention. The training program comprises two parts: elemental training and functional training. All of the activities can be carried out without any need for special equipment.

Elemental training focused on an awareness of breathing, an awareness of the body parts, and dual-task training. Awareness of breathing and of the body parts required the participants to direct their full attention to the sensations of breathing and to a specific body part, which required a certain degree of sustained and selective attention. The dual-task training required the participants to recite personally related telephone numbers, names, and places while walking.

Patients with cognitive impairment tend to have impaired attention, particularly divided attention, which can make it very difficult for them to perform everyday tasks because they are easily distracted (Perry & Hodges, 1999). Therefore, functional training was included in this study to focus on daily living tasks that rely on a certain degree of attention and are often encountered in real daily life. The participants were instructed to prepare a shopping list for meal preparation, choose correct pictures of food that contained an expiration date, read simple maps and determine location on the map, prepare a daily drug box, and determine the important information from common bills. All tools and instruments were prepared as real objects instead of being computer based.

Each session lasted 45 min and began with 5 min of introduction or recapitulation of the previous session, followed by 20 min of training in all three elements. The latter half of the session included 15 min of functional training and concluded with a 5-min review and feedback session. The trainer followed the structured training manual to ensure the consistency of the training content and form across the groups.

Health-related education program. The health-related education program used in the control group included sessions on various health topics relevant to older adults, such as medications and common health problems, and was delivered by means of didactic lectures and interactive group discussions. Each session lasted 45 min and began with 5 min of introduction or recapitulation of the previous session, followed by 30 min of lectures on the health topics. Another 10 min was left for open discussion among the participants and the instructor. The participants could share their own experiences on related topics. The total number of contact hours, the frequency of the sessions, and the setting in which the health-related education program was delivered were comparable to those of the IATP. The health-related education program thus served as an active control to the IATP to control for the general beneficial effects of mental and social activities delivered in a center-based group setting because previous studies have shown that activities that stimulate cognition or contain either mental or social elements are associated with a reduced risk of dementia (Karp et al., 2006; Wilson et al., 2002).

Randomization and blinding. We used block randomization in this study. Each block consisted of eight patients and aimed at a 1:1 ratio between the two groups. In the randomization procedure, each participant was assigned a special code generated by a computer. One independent team member who was not involved in enrollment, training, or data collection performed all randomization. The enrollment assessments and outcomes were blinded to the randomization status. The trainers were blinded to the results of the baseline and follow-up assessments. The participants were assumed not to be blinded to the intervention. To reduce the possible expectancy bias, during the informed consent procedure, we tried to emphasize that there is no evidence to support a difference in terms of effectiveness between the two arms.

Assessment schedule. The primary and secondary outcome indicators were collected at three time points: before intervention (T0), after the intervention phase (3 months after the baseline assessment [T1]), and after the monitoring phase (6 months after the baseline assessment [T2]).

Assessment Tools and Clinical Outcomes

Primary outcome indicator. To detect the potential benefits of IATP on cognitive function and daily functioning, the Clinical Dementia Rating–Sum of Boxes (CDR-SOB; Morris, 1993) was used as the primary outcome indicator. The CDR is obtained by means of semistructured interviews of patients and informants, and cognitive functioning is rated in six domains of functioning: memory, orientation, judgment and problem solving, community affairs, home and hobbies, and personal care. Each domain is rated on a scale of 0 to 3 marks. The global CDR score is computed via an algorithm. The CDR-SOB score is obtained by summing each of the domain box scores to yield a score ranging from 0 to 18. The optimal ranges of the CDR-SOB scores and their corresponding global CDR scores were 0.5 to 4.0 for a global score of 0.5, 4.5 to 9.0 for a global score of 1.0, 9.5 to 15.5 for a global score of 2.0, and 16.0 to 18.0 for a global score of 3.0. Each of the CDR raters in this study had completed the reliability assessment training provided by the dementia research unit of Washington University in St. Louis, Missouri. The CDR-SOB has been demonstrated to be more sensitive in capturing early functional changes in the preclinical phases of Alzheimer's disease (CDR 0.5). It also tracks changes across time with better precision (O'Bryant et al., 2008).

Secondary outcome indicators. The cognitive assessments included the Cantonese version of the Mini-Mental State Examination (CMMSE; Chiu, Lee, & Chung, 1994); the Chinese version of the Alzheimer's Disease Assessment Scale–Cognitive Subscale (ADAS-Cog; Chu et al., 2000); a 10-min assessment of delayed recall, digit and visual span, the Category Verbal Fluency Test (CVFT; Chiu et al., 1997); and Trail Making Tests A and B (TMT-A and

TMT-B; Bowie & Harvey, 2006). The attention domain was assessed with the Attention Network Test (ANT), which consists of a single 30-min session and includes a combination of cued reaction time and the flanker task to allow a comprehensive assessment of attention (Fan, McCandliss, Sommer, Raz, & Posner, 2002). Subjective cognitive deficit was measured with the Memory Inventory for the Chinese, a 27-item questionnaire used to assess the awareness of memory deficits in Chinese patients with Alzheimer's disease (Lui, Lam, & Chiu, 2006). Symptoms of depression were assessed with the Hamilton Depression Rating Scale (HAM-D) 17-item version (Hamilton, 1967).

Ethical concerns. The study was performed in accordance with the Declaration of Helsinki. Approval for the study was obtained from the Joint Chinese University of Hong Kong–New Territories East Cluster (Joint CUHK-NTEC) Clinical Research Ethics Committee. Written informed consent was obtained from all participants before commencement of the study. The trial was registered under the Chinese Clinical Trial Registry (Identifier: ChiCTR-TRC-12002622).

Statistical Analyses

The baseline demographic data and other baseline measurements were compared between the IATP and control groups with Pearson's chi-square test (for categorical variables) and independent-samples *t* tests (for numeric variables). We performed a series of ANOVA with group (IATP group vs. control group) and time (T0, T1, and T2) as the independent variables. The primary and secondary outcome variables served as the dependent measures. Statistical significance was assumed for *p* levels of less than .05. All data were analyzed based on the intention to treat principle.

Results

Comparison of Baseline Characteristics

One hundred participants underwent initial screening; 93 were enrolled in the study and were randomized into two groups. Forty-seven participants attended the IATP and 46 attended the health-related education program (Figure 2).

The mean age of the participants was 73.9 years; the oldest was 90 years of age, and the youngest was 60 years of age. Seventy-five participants (81%) were women. The participants had an average of 6 years of education. Their mean score on the CDR-SOB was 0.94, which corresponded to a global CDR of 0.5, indicating mild impairment in cognitive function without dementia.

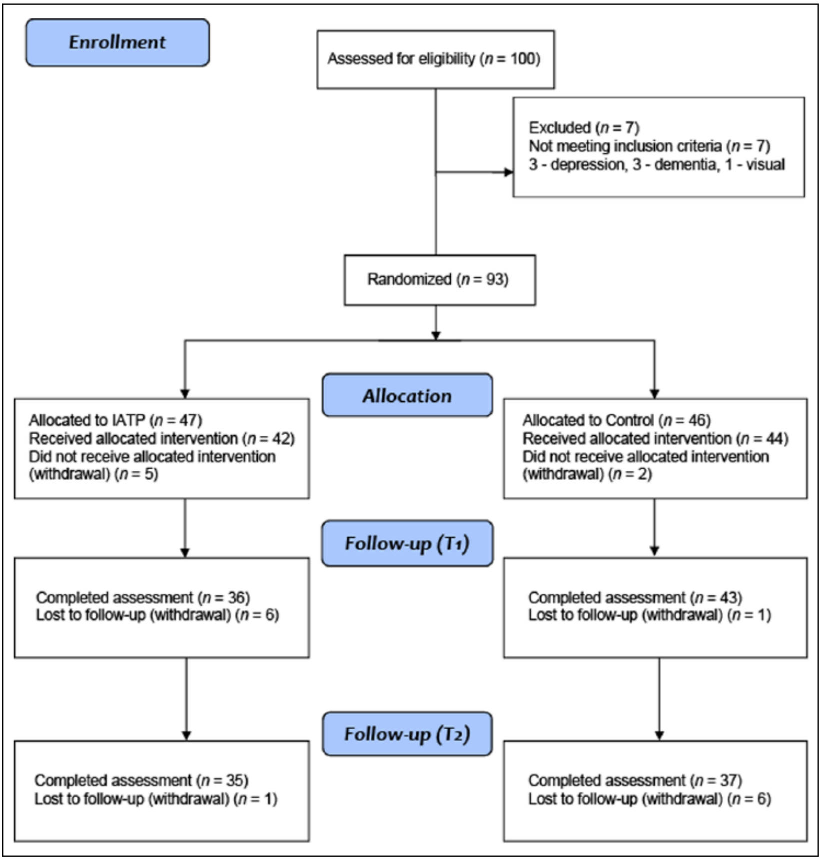

Figure 2. Flow chart of current study.
Note. IATP = Integrated Attention Training Program.

This finding matched the expectation of the target group. The CMMSE mean score was 27.3. No statistically significant difference was found in the baseline demographic characteristics, cognitive function, depression scores, or functional level between the two groups (Table 1). The mean score on the Memory Inventory for the Chinese in the IATP group was 8.2, which was statistically significantly higher (p = .041) than that in the control group (6.9; see Table 1 for details).

Program adherence. The rates of attendance during the intervention phase were 73.4% and 73.1% for the IATP and control groups, respectively. The

Table 1. Demographic and Cognitive Characteristics at Baseline.

	Overall *N* = 93 *M* (*SD*)	IATP *N* = 47 *M* (*SD*)	Control *N* = 46 *M* (*SD*)	*p* value
Age, years	73.9 (7.4)	72.9 (7.6)	75.0 (7.3)	.187
Sex, *n* (%)				.127[a]
Female	75 (81%)	35 (74%)	40 (87%)	
Male	18 (19%)	12 (26%)	6 (13%)	
Education, years	6.2 (4.7)	6.1 (4.6)	6.2 (4.9)	.893
Exercise, *n* (%)				.740[b]
Regular	84 (90%)	43 (91%)	41 (89%)	
No regular	9 (10%)	4 (9%)	5 (11%)	
CDR-SOB	0.94 (0.58)	0.95 (0.61)	0.94 (0.56)	.922
ANT				
Grand mean effect	844.1 (170.6)	826.6 (154.5)	861.9 (185.5)	.320
Accuracy (%)	84.7 (18.0)	84.4 (15.9)	85.0 (20.1)	.874
CMMSE	27.3 (2.0)	27.4 (1.7)	27.3 (2.2)	.807
ADAS-Cog	10.4 (4.1)	10.8 (4.6)	10.0 (3.5)	.362
Delayed recall	5.4 (2.4)	5.2 (2.7)	5.6 (2.0)	.377
Digit forward score	10.4 (2.2)	10.5 (2.1)	10.3 (2.4)	.694
Digit backward score	4.5 (2.1)	4.2 (1.9)	4.9 (2.3)	.086
Visual forward score	6.4 (1.4)	6.4 (1.4)	6.5 (1.4)	.799
Visual backward score	4.8 (1.5)	4.8 (1.6)	4.7 (1.5)	.777
CVFT	39.4 (9.7)	38.3 (9.9)	40.4 (9.6)	.297
TMT-A	17.8 (10.4)	17.7 (11.1)	17.8 (9.9)	.947
TMT-B	94.2 (61.7)	94.5 (59.1)	94.0 (64.8)	.770
MIC	7.6 (3.1)	8.2 (3.3)	6.9 (2.8)	.041
HAM-D	2.2 (2.5)	2.0 (2.3)	2.5 (2.7)	.325

Note. IATP = integrated attention training program; CDR-SOB = Clinical Dementia Rating–Sum of Boxes; ANT = Attention Network Test; CMMSE = Cantonese version of the Mini-Mental State Examination; ADAS-Cog = Chinese version of the Alzheimer's Disease Assessment Scale–Cognitive Subscale; CVFT = Category Verbal Fluency Test; TMT-A = Trail Making Test A; TMT-B = Trail Making Test B; MIC = Memory Inventory for the Chinese; HAM-D = Hamilton Depression Rating Scale.
[a]Pearson chi-square.
[b]Fisher's Exact Test.

completion rates were 74.5% and 80% for the IATP and control groups, respectively. Five participants (10.6%) in the IATP group and two (4.3%) in the control group dropped out before the programs began. Six participants

(14.2%) in the IATP group and one (2%) in the control group dropped out during the 3-month intervention. During the monitoring phase, only one participant (3%) in the IATP group completely finished the home practice session. Five participants (14%) finished more than half of the sessions, and 17 participants (47%) finished less than half of the sessions. Thirteen participants (36%) reported that they never attempted the home practice of IATP.

Comparing the effect between IATP and control groups. A two-way mixed-design ANOVA (with IATP vs. control as the between-subjects variable and time as the within-subject variable) was conducted to compare the effects between the IATP and control groups (see Table 2 for details). We only found significant interactions between group and time in the Digit Forward Score ($p < .05$; effect size, 0.057). No significant interactions were seen between group and time in the CDR-SOB and the other secondary outcomes.

Differences between baseline and end-of-study values. We used one-way repeated-measures ANOVA with post hoc comparisons to evaluate the differences between the baseline and end-of-study values in each group (see Table 2 for details).

The IATP group showed significant improvement in the grand mean effect ($p < .05$) and accuracy ($p < .05$) in the ANT, the Digit Backward Score ($p < .05$), the CVFT ($p < .05$), and TMT-A ($p < .01$) immediately after intervention. These improvements were sustained 3 months after intervention. Significant improvement in the TMT-B ($p < .01$) appeared 3 months after intervention.

The control group showed significant improvement on the CVFT ($p < .05$) and TMT-A ($p < .05$) immediately after invention. These improvements were sustained 3 months after intervention. Significant improvement was seen in delayed recall ($p < .01$) initially after the intervention, but it later showed a significant decline 3 months after the intervention ($p < .05$).

Discussion

In our study, IATP did not show effects in cognition and functioning that were superior to those of the control group. Surprisingly, no significant difference was seen in the attention domain, which was specifically targeted in the IATP. There are two possible explanations. Despite an improvement in cognition and functioning, the difference in the effect size between the IATP and control groups may have been too small to be statistically significant. The effect size of improvement could be limited by a ceiling effect, which means that the subjects' attention deficit may have been very mild or even absent. There

Table 2. Change of Primary and Secondary Outcome Measures From T0, T1, and T2 in IATP and Control Groups.

	IATP (n = 47)			Post hoc comparison *p* values		Control (n = 46)			Post hoc comparison *p* values		Effect size
	T0	T1	T2	T0 vs. T1	T0 vs. T2	T0	T1	T2	T0 vs. T1	T0 vs. T2	Group × Time (effect size)
CDR-SOB	0.95 (0.61)	1.14 (0.67)	1.37 (0.81)			0.93 (0.56)	1.16 (0.73)	1.54 (0.88)			0.008
CMMSE	27.36 (1.71)	26.64 (2.60)	26.74 (2.27)			27.26 (2.24)	27.47 (2.15)	26.61 (2.75)			0.003
ADAS-Cog	10.79 (4.55)	10.36 (4.69)	10.35 (4.38)			10.01 (3.50)	8.81 (4.30)	9.56 (4.40)			0.001
Delayed recall	5.15 (2.73)	4.92 (2.66)	4.23 (2.38)			5.59 (1.96)	6.23 (2.48)	4.58 (2.36)	**	*	0.037
ANT											
Grand mean effect	826.57 (154.49)	808.69 (152.14)	741.17 (168.26)	*	**	861.91 (185.54)	811.86 (160.79)	800.33 (168.62)			0.002
Accuracy (%)	84.36 (15.87)	90.17 (12.83)	93.46 (8.39)		**	84.96 (20.13)	90.65 (11.40)	89.44 (16.18)			0.014
Digit forward score	10.49 (2.11)	10.50 (2.06)	9.94 (2.40)			10.30 (2.39)	11.02 (2.01)	10.56 (2.25)			0.057*
Digit backward score	4.15 (1.88)	4.69 (2.12)	4.86 (1.65)	*	*	4.91 (2.35)	5.02 (2.30)	4.92 (2.45)			0.009
Visual forward score	6.40 (1.39)	6.53 (1.54)	6.03 (1.18)			6.48 (1.39)	6.86 (1.25)	6.69 (1.28)			0.036
Visual backward score	4.81 (1.58)	4.61 (2.11)	4.66 (1.61)			4.72 (1.52)	4.84 (1.23)	5.17 (1.56)			0.012
CVFT	38.32 (9.87)	43.47 (10.25)	44.06 (11.08)	*	**	40.43 (9.59)	43.44 (9.37)	43.72 (9.79)	*	*	0.008
TMT-A	17.70 (11.08)	17.31 (12.85)	13.14 (7.42)	**	**	17.85 (9.88)	15.45 (10.12)	13.76 (6.75	*	**	0.002
TMT-B	107.51 (76.19)	112.97 (84.85)	64.03 (36.22)			102.87 (76.16)	94.40 (74.90)	91.33 (74.27)			0.031
MIC	8.21 (3.34)	8.22 (4.37)	7.60 (4.39)			6.89 (2.77)	6.28 (3.89)	7.50 (3.62)			0.040
HAM-D	1.96 (2.34)	2.28 (2.99)	2.46 (3.19)			2.48 (2.72)	2.28 (2.95)	2.97 (2.91)			0.009

Note. Standard deviation in parentheses. Effect size measured by partial eta square, IATP = integrated attention training program; CDR-SOB = Clinical Dementia Rating–Sum of Boxes; CMMSE = Cantonese version Mini-Mental State Examination; ADAS-Cog = Chinese version of the Alzheimer's Disease Assessment Scale–Cognitive Subscale; ANT = Attention Network Test; CVFT = Category Verbal Fluency Test; TMT-A = Trail Making Test A; TMT-B = Trail Making Test B; MIC = Memory Inventory for the Chinese; HAM-D = Hamilton Depression Rating Scale.
*p < .05. **p < .01

was not much room for improvement in those subjects. Alternatively, it is possible that both the IATP and control groups showed no effect on cognition and functioning. It would be possible to determine which explanation is more reasonable by examining the pre-post comparisons in each group.

For the IATP group, the pre-post treatment improvement was significant for attention tasks including accuracy and for the grand mean effect of the ANT, TMT-A, TMT-B, and Digit Backward, which matched the content of the training. For the control group, the pre-post treatment comparison also showed improvement in a few cognitive domains that can be explained by the non-specific training effect in the control intervention. However, there was no improvement in global cognition and functioning measured by the CDR-SOB and CMMSE in either group. Based on these results, we may conclude that the lack of a difference in the attention domain between the groups was a result of the small effect size. The lack of a difference in global cognition and functioning between the groups was a result of the insignificant effect of intervention in both groups.

The improvement in the attention domain in the IATP group was sustained for at least 3 months after the training program. Although we asked the participants to practice IATP at home, the adherence rate was poor. The sustained improvement in the attention domain was likely due to the lasting effects of the intervention phase rather than the home practice effect. This result indicates the sustained benefit of structural CT in subjects with cognitive impairment on specific cognitive domains targeted for training.

Theoretically, improvement of attentional function may lead to improved performance in other cognitive domains through changes in the underlying higher cognitive functions, such as working memory, in healthy humans (Kelly, Foxe, & Garavan, 2006; Petersen, van Mier, Fiez, & Raichle, 1998). In this study, the IATP group showed improvement in TMT-B and CVFT, which may suggest some generalized effect on other cognitive domains such as mental flexibility and executive function. However, improvement in CVFT was also seen in the control group, which suggests another possible explanation. The improvement in non-targeted cognitive domains may be a result of a non-specific training effect instead of a specific attention training effect in the IATP group. Whether the improvement of attentional function may lead to improved performance in other cognitive domains remained inconclusive in this study.

Feasibility and Acceptance of Program and Study

The attendance rates in both groups were around 70% in this study, which is considered acceptable given the background of unsubsidized participants and a demanding course. The IATP was feasible and was accepted by local older adults. There was higher dropout rate in the IATP group than in the control group even before the program began, which could possibly be explained by disappointment with their randomized group assignment as a health education program sounds more familiar and less demanding than a newly developed IATP. A higher dropout rate was also noted in the IATP group during the intervention phase. According to questionnaires collected from the dropout participants, the main reason was the difficulty level of the IATP. The participants reported that the IATP was too easy or too difficult for them, which affected their interest in continuing the training. The IATP was run with a "one size fits all" design, which might have led to this problem. Under-stimulation or a failure to follow the training procedure would have reduced the training effect. A personalized training program may be more effective in CT programs (Mahncke, Bronstone, & Merzenich, 2006) and could allow under-stimulating and over-challenging tasks to be avoided, which might decrease the dropout rate and enhance the training effect. The tasks that target different attention systems and functional training could also be modified to enhance the participants' interest.

The low adherence rate of self-practice IATP at home was noted during the monitoring phase. This phenomenon was similar to that in other forms of self-administrated medical treatments, including taking medications at home (Narasimhan, Hardeman, & Johnson, 2011). Self-practice at home requires a high level of self-discipline and a high degree of motivation. Participation in the training program in a community older adult center seemed to be more feasible and effective than self-practice at home according to this result. To make the home practice program more feasible and effective, other elements, including a real-time feedback mechanism, should be included to enhance the subjects' motivation.

Limitations

This study has a few limitations. First, the participants were not blinded because it is difficult to perform a blinding procedure in such a setting. This may have increased the expectancy bias. We attempted to reduce this bias during the informed consent procedure by emphasizing that no evidence supported the difference in terms of effectiveness between the two arms. Second, we used subjective cognitive complaints without dementia as the inclusion criterion in this study. This would be considered a less stringent criterion than the use of mild cognitive impairment, neuropsychological tests, or biomarkers. It may have introduced more heterogeneity in the level of cognition among the participants, which may have affected the interpretation of the results and the training effect. However, the classification system between the normal cognitive state and dementia remains controversial. The validity and reliability of a group with mild cognitive impairment according to Petersen's criteria is still doubtful and debatable (Stephan et al., 2007). In addition, our aim was to develop a simple and easily deliverable training program in a community older adult center. It may not be practical for a community older adult center to recruit participants according to more stringent criteria in daily practice. Third, the actual number of participants recruited in this study was less than our initial planned sample size due to our limited resources and time. Despite that, the sample size in our study still achieved a statistical power of 86.9% under the assumption of medium effect sizes on the dependent variables between the IATP and control groups (p = .05).

Conclusion

This is the first local study to assess an attention-based CT program that adopts a simple, practical, and integrated approach in a Chinese population. IATP showed a sustained domain-specific effect but no significant effect in global cognition and functioning. No evidence was found to suggest that IATP had a superior benefit for cognition and functioning to that of non-specific mental stimulation in a group format. The generalized effect of improvement in attentional function to other cognitive domains remains inconclusive. The lack of a difference in functioning and global cognition suggests that further studies are needed to determine the role of the attention domain in CT among older adults with cognitive impairment.

Acknowledgments

I would like to express my gratitude to research assistants Mr. Jonathan Liu, Ms. Law Hei Tung, and Ms. Alicia Chan for their support and help with the study. The participation of all older adult centers and participants in this study is deeply appreciated.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

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