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Preserving Cognition Through an Integrated Cognitive Stimulation and Training Program

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Background: Cognitive decline leads to disability and increased health care expenditures. *Methods:* Effectiveness of an intervention to stimulate multiple cognitive domains was determined using a format combining traditional and computer-based activities (Integrated Cognitive Stimulation and Training Program), 45 minutes a day, 2 days a week, for 6 weeks. Nonimpaired, mildly, and moderately-impaired participants > age 65 (n = 32) were randomly allocated into a control or experimental group. Using a repeated measures design participants were tested again postintervention and at 8 weeks follow-up. *Results:* Statistically significant improvement on Dementia Rating Scale scores occurred for mildly and moderately impaired treatment participants (n = 15). Statistical significance was demonstrated on subscales of the WMS-III: Logical Memory I and Logical Memory II. *Conclusion:* Blending computer-based with traditional cognitive stimulation activities shows promise in preserving cognitive function in elders. Future studies to explore efficacy in larger, more diverse samples are needed.

Keywords: cognitive impairment; cognitive stimulation; cognitive training; computer-based training

Introduction

Cognitive decline is one of the consequences of aging most feared and memory complaints are subjectively reported by a large proportion of older adults.[1-7] The prevalence of cognitive impairment appears to be wide-spread and the majority of cases are undiagnosed.[8] Cognitive deterioration leads to decay of functional ability and contributes to health care expenditures 10 times greater than for those without such deficits.[9]

Currently, the cognitive intervention framework is largely a medical approach where individuals in the early stages of a dementia are given a cholinesterase inhibitor as the primary intervention. Pharmacological interventions lead to small, limited improvements in cognition and function, but appear not to affect the underlying cause of dementia and can have significant side effects.[10-12] Few additional treatment options are offered to disrupt the deleterious trajectory of progressive decline.[13] Once the diagnosis of dementia is made, the focus becomes centered on disability rather than capability.[14]

Some researchers have suggested that cognitive skills should be the target of rehabilitative interventions to attenuate or delay age-related cognitive decline and slow the progression of a dementing disease process.[15-19] The logic behind this belief has been predicated on research which demonstrates most individuals with mild-to-moderate dementia are not totally amnestic,[20] and physiological plasticity remains present in the brain allowing for synaptogenesis and increased synaptic complexity.[21] Thus, individuals with mild-to-moderate dementia continue to have the ability for new learning and memory enhancement. This validates the need to continue to develop and test interventions to preserve cognitive ability and counteract the progressive decomposition of ability for thinking, reasoning, and the consolidation of new memories.

Cognitive Stimulation/Training

Cognitive stimulation (CS) interventions are based on the view that consistent engagement in a variety

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of mental activities enhances cognitive and social functioning.[22,23] Empirical evidence is strongly supporting the view that individuals who remain dynamically engaged in activities that require the use of cognitive abilities may have less risk for developing dementia and slower progression of cognitive decline.[24,25]

Cognitive training (CT) involves guided practice on a set of standard tasks designed to reflect specific cognitive functions such as memory, attention, language, and executive function.[22] There is a growing body of scientific evidence that suggests performance improvement with training is possible and that it extends to the oldest old.[26-29] The underlying assumption is that regular practice has the potential to maintain functioning in a given cognitive domain with the effect generalizing beyond the immediate training context.[22] Although there are conflicting findings regarding the efficacy of CT in those with cognitive impairment, conclusions of a comprehensive review[30] suggested that CT interventions are "probably efficacious" in slowing cognitive decline. Likewise, comprehensive reviews of memory stimulation studies with patients with Alzheimer disease (AD) indicated efficacy of specific techniques.[31,32] More recently, in a large, multisite, randomized trial (N = 2802) the Advanced Cognitive Training for Independent and Vital Elderly (ACTIVE) study group found that training interventions were also effective in improving targeted abilities in nonimpaired elders[33] and that the improvement continued 5 years after the initiation of the intervention.[34]

Mounting research evidence in the area of brain plasticity and modifiability indicates that novel experiences increase brain activity and trigger neurochemical processes that maintain and encourage dendrite growth and synaptic complexity.[21,35,36] In behaviorally oriented research the concept of cognitive plasticity usually refers to learning gain.[26] A variety of novel and diverse activities may also captivate interest encouraging active participation[37-40] as well as lower the risk for developing AD.[39] The use of computer programs for CS and CT are 2 such strategies with today's older adults who were educated and spent the majority of their working years in an era in which computer technology played a minimal role. In the past, CS and CT tasks have been pencil and paper based or involved analogs of activities of daily living. Because cognition encompasses both perceptual-organizational and psychomotor operations involving a multitude of neurocognitive dimensions, the computer as a platform for delivery of CS and CT has the advantage of facilitating interaction by accommodating these physical and emotional characteristics of the adult.[40]

Nascent studies indicate that interactive computer programs may be an effective intervention to improve cognitive function and delay loss of cognitive ability[41,42] In normal elders, memory performance was enhanced via practice on computerized explicit and implicit memory tasks.[43] Likewise, in individuals with age-associated memory impairment but not dementia, findings have indicated significant post computer-assisted cognitive training improvements in primary and secondary working memory for verbal and visual stimuli on parameters of information processing speed, learning, and inference tendency.[44] Further support for the benefits of computer programs comes from a study of computer-aided memory-matching tests with participants stratified into 3 cognitive levels: low–Mini-Mental Status Exam (MMSE) scores of 13 to 17, medium-MMSE scores of 18 to 23, and high cognitive functioning-MMSE scores of 24 to 30.[45] MMSE, short-term memory, long-term memory, fluid intelligence, and attention scores all significantly improved for participants in each group over controls.[45]

Other studies have used digital photographs or simulations of "real-life" situations, household tasks, and personally familiar environments to create interactive computer-based CT programs.[46-48] Although no overall cognitive gains were found on standardized psychometric measures for any of these "real-life" studies, the trend was for improvement in scores, with fewer errors and less need for assistance.

Despite the longevity of nonpharmacological memory enhancement and cognitive training interventions, their effects remain open to question. Issues with these studies such as the lack of solid theoretical base, small sample size, lack of randomization and appropriate control groups, and little attention to representativeness or heterogeneity of participants warrants continued investigation. Additionally, cognitive functions are not used in isolation from one another. However, most studies focused on a single cognitive task, usually memory enhancement, without regard for the elaborate collaboration with other mentative processes required to create and maintain a viable healthy mind capable of flexibility in thinking, recalling, linking, and reacting to one's world. Thus, it remains unclear as to which types of cognitive stimulation and training interventions are most advantageous to elicit improvement in cognitive performance, including memory. Likewise, early empirical evidence related to the effectiveness of computer applications to attenuate the symptoms of cognitive decline supports further investigation of this intervention.

The aim of the study reported here was to compare the efficacy of an Integrated Cognitive Stimulation and Training Program (ICSTP) of therapy in individuals older than 65 years having various levels of cognitive impairment with similar individuals in a wait-list control group. Embedded with memory enhancement opportunities, the ICSTP was designed to bolster executive functioning and mental flexibility through blending computer applications with traditional pencil and paper deliberate practice tasks. The goal was to determine the effect of the ICSTP on mental status and dementia scores, short-term and long-term memory, and delayed recall.

Methods

Study Design and Participants

A repeated measures experimental design with an intervention and comparison wait-list control group was used to test the efficacy of ICSTP in a population of individuals aged 65 and above in a rural geographic area. The sample, recruited through flyers, explanatory invitational letters, and informational sessions, were residents of a retirement community with separate independent living houses, a skilled nursing facility, a personal care facility, and an Alzheimer disease unit. A monthly Alzheimer's Education program provided an ongoing connection with surrounding neighborhoods from which additional participants were drawn. This site allowed for an adequate population and for control of institutional differences.

The inclusion criteria were (*a*) medically stable, (*b*) physical ability sufficient to use a computer mouse and touch screen, (*c*) visual and hearing acuity sufficient to read enlarged printed text, see a computer screen, and to hear the instructions and responses with reasonable accommodations, such as headphones, and (*d*) minimum score on Mini-Mental Status Exam (MMSE) of 11. Forty-five individuals or their legal guardians signed informed consent as approved through the researchers' university institutional review process. Thirty-seven individuals met the inclusion criteria.

Cognitive testing separated participants into ability level: no impairment, mild impairment, or moderate impairment. These cognitive groups were then randomized into the treatment (n = 17) and the control (n = 20) groups. Five participants withdrew leaving the final sample at 15 participants in the treatment group and 17 participants in the control group. One control participant completed baseline and intervention testing only. Follow-up data were obtained from 31 participants for a retention rate of 98%. Sample and attrition data are noted in Table 1. The participants, Caucasian and predominately female, ranged in age from 65 to 94 years (m = 78.6, SD = 8.43). Medications remained the same throughout the study.

Table 1. Sample and Attrition

	Control Group	Treatment Group
N = 37		
Attrition		
Death	1 male[a]	
Medically unstable	1 female[a]	
Afraid to leave spouse alone	1 female[b]	1 female[b]
Severe hearing deficit		1 male[a]
Final sample (N = 32)	n = 17	n = 15
Nonimpaired	8 (3 males)	5 (1 male)
Mildly impaired	4 (0 male)	5 (0 male)
Moderately impaired	5 (1 male)	5 (0 male)
Living arrangements		
Independent	n = 7	n = 4
Independent with spouse	n = 7	n = 3
Assisted living	n = 0	n = 4
Nursing home	n = 3	n = 4
Cognitive Med. Use		
None	n = 10	n = 12
Cholinesterase inhibitors and/or antiglutamatergic	n = 6	n = 1
Antipsychotic	n = 0	n = 1
Antipsychotic and cholinesterase inhibitors and/or antiglutamatergic	n = 1	n = 1
Antidepressant Use		
No	n = 5	n = 5
Yes	n = 12	n = 10

[a] Moderately impaired.
[b] Nonimpaired.

Procedures

The researcher (a doctorally prepared psychiatric clinical nurse specialist), a research assistant, and geropsychiatrist collected outcome data for both the control and treatment groups. Data were collected three times: once before the implementation of the intervention (baseline) and again after completion of the intervention (intervention—week 6) and after 8 weeks of no-contact following the intervention (residual—week 14). The use of residual testing was done to determine durability of the program's effect. The psychiatric clinical nurse specialist researcher and research assistants (trained in the intervention protocol by the researchers) provided the ICSTP.

Intervention

The Integrated Cognitive Stimulation and Training Program (ICSTP) was designed by the researchers as a planned program of interventions which incorporated computer technology augmented with pencil and paper based stimulation and training activities to simultaneously target multiple aspects of cognition and thus impact global memory processing and executive functioning. The ICSTP intervention occurred in the late morning, 2 consecutive days of the week, and was 45 minutes in duration each day. The ICSTP was composed of 3 successive 15-minute sessions with each participant completing all 3 sessions each day. Groups of 5 participants were in each session, with each participant completing tasks independently.

The Computer Session used 2 software programs, Sound Smart and Captain's Log, to train various cognitive functions. Sustained attention and activation of visuomotor processing occurred when the participant moved the mouse and pressed the button or used the touch screen in response to various exercises presented on the screen (eg, matching colors or shapes, finding hidden pairs, calculating math problems, and identifying patterns and sequences—both auditory and visual). The programs engaged the participant in sensory and cognitively demanding exercises, where to make progress, the participant had to concentrate and perform increasingly more difficult stimulus recognition, discrimination, sequencing, and memory tasks under conditions of close attentional control and novelty. For each phase, 80% correct thresholds were established.

The Mental Stimulation Session included pencil and paper exercises to prompt the use of specific cognitive functions. Each week visual-spatial processing was stimulated through exercises with hidden picture drawings, mazes, and geometric activities. Crossword puzzles, categorization of items into functional classes, and mathematical calculation were used to stimulate deliberation, interpretation, and reasoning processes. Language stimulation focused on word-finding activities, anagrams, and eliciting facts. Use of working memory was promoted with activities such as short-term memory recall of prose and sentence completion. Recognition memory included exercises such as search-a-word puzzles, picture recognition, and name-face association activities.

The focus in the Integration Session was to blend mental stimulation into ecologically plausible activities. Problem solving and reasoning tasks focused on recognition, appraisal, generation of alternative solutions, and decision-making (eg, determining what to do with a fire in the home; what steps to take when purchasing a new item for the home). Attention and concentration were promoted with activities such as following a set of written directions, or looking up service providers in telephone directories and determining the best to contact. Procedural memory was stimulated with "real-life" tasks, such as putting objects in the correct place, (eg, table setting), determining which items are needed to dress correctly to go on a hiking trip, writing directions to navigate from one geographic location to another, and using money/making change, managing a stock portfolio, or writing checks to pay bills.

Measurement

Outcome measures were chosen to broadly capture change in performance and were not specifically presented as targeted tasks in the intervention. Mental status was measured using the MMSE, an 11-item standardized cognitive screen that includes items on orientation, registration, short-term memory, attention and concentration, language usage, and constructional capacity. The score is the sum of correct responses and can range from 0 to 30; a score of less than 24 indicates global cognitive impairment with individuals having at least 8 years of education. Reported test-retest reliability is .86.[49,50] Usually, a score between 23 and 18 indicates mild cognitive impairment and scores below 17 indicate moderate cognitive impairment.[45,51-53]

The Dementia Rating Scale (DRS)[54] is a widely used neuropsychological measure of cognitive status in adults with cortical impairment, particularly of the degenerative types. It has been shown to have test-retest reliability ($r = .97$)[55,56] and content validity.[57,58] The maximal total score of 144 is obtained through the summation of scores on 5 subscales (ie, Attention, Initiation and Perseveration, Construction, Conceptualization, and Memory). The suggested cognitive impairment cutoff score is 123.[55] Mild dementia cutoff score is 115 and scores of less than 115 are staged as moderate dementia.[59] Correlations between the Wechsler Memory Scale – III (WMS-III) indexes and the DRS are in the moderate-to-high range.[60]

Logical Memory I (LMI), Logical Memory II (LM II), and Letter–Number Sequencing (LNS) subscales of the Wechsler Memory Scale-III[60] were used to test immediate and delayed memory in the

Table 2. Baseline Measures of Central Tendency, Dispersion, and Univariate Analyses for Demographic Variables

	Control Group (n = 17)		Treatment Group (n = 15)			
Variable	M	SD	M	SD	*F*	*P*
Age (years)	76.8	8.49	80.9	8.04	1.19	.284
Education (years)	14.1	3.62	15.3	2.87	1.61	.215
Living arrangements[a]	2.16	1.21	2.53	1.19	1.36	.253
Cognitive med. use[b]	1.58	.838	1.40	.910	.799	.379
Antidepressant use[c]	1.68	.478	1.67	.488	.146	.706

[a] Living arrangement coding: 1 = independent in community, 2 = community dwelling with spouse, 3 = assisted living; 4 = nursing home.
[b] Cognitive med use coding: 1 = none; 2 = cholinesterase inhibitors and/or antiglutamatergic; 3 = antipsychotic; 4 = antipsychotic and cholinesterase inhibitors and/or antiglutamatergic.
[c] Antidepressant use coding: 1 = no; 2 = yes.

auditory dimension. Briefly, LMI is an immediate memory scale with a reported reliability coefficient between .81 and .90 for the range of ages in this study.[60] The examiner reads 2 different stories, and immediately after hearing each story the participant is asked to retell it from memory. Scoring is based on the accuracy of retelling the stories (range 0-75 points). Twenty-five to thirty-five minutes after LMI, the delayed (long-term) memory scale LM II (r = .77-.87) is administered to collect recall scores (range 0-50 points).[60]

Letter–Number Sequencing is a complex working memory task that focuses on the ability to attend to information, hold that information in memory, and to formulate a response based on that information. This test requires the participant to order sequentially a series of numbers and letters presented orally by the examiner in a specified random order. The participant must first remember the numbers and letters and then reorganize the numbers into ascending order and the letters into alphabetical order; score range is 0 to 21 points (r = .75–.88).[60]

Statistical Considerations

Statistical analyses of raw scores were used to test the hypothesis: participants involved in a structured cognitive stimulation intervention (ICSTP) two times per week for 6 weeks will show improvement from baselines scores in measures of mental status, dementia, and memory over participants in the wait-list control group. Additionally, it was speculated that the treatment group would maintain this improvement 8 weeks following discontinuation of the intervention.

In addition to the small sample size, examination of relative frequency distributions revealed outcome variables with degrees of skewedness that rendered the use of parametric statistical tests inappropriate. The Friedman test was computed to examine changes in outcome scores over time: baseline, intervention, residual. Where differences were found, comparisons of each pair were analyzed separately using Wilcoxon Matched Pairs Signed Ranks. Data were analyzed using SPSS, version 14.0 (2005) for Windows.

Table 3. Baseline Measures of Central Tendency, Dispersion, and Univariate Analyses for Outcome Variables

	Control Group (n = 17)		Treatment Group (n = 15)			
Variable	M	SD	M	SD	*F*	*P*
MMSE	24.2	7.29	24.6	5.77	.601	.445
DRS	118.2	29.5	117.7	25.5	.434	.516
LNS	7.53	4.14	5.93	3.52	1.76	.195
LMI	26.2	17.4	20.3	21.2	.030	.864
LMII-TRS	11.5	10.4	8.33	12.1	.001	.981

Abbreviations: DRS, Dementia Rating Scale; LNS, Letter−Number sequencing; LMI, Logical Memory I; LMII-TRS, Logical Memory II–Total Recall Score; LMI, Logical Memory I; MMSE, Mini-Mental Status Exam.

Results

Univariate analyses of variance did not yield any significant differences between the treatment and control group for demographic and outcome variables and confirmed the homogeneity of the sample prior to the administration of the intervention. Baseline measures of central tendency and dispersion of the demographic characteristics are presented in Tables 2 and 3.

Table 4. Friedman Test of Difference Over Time (N = 31)

Variable		M	SD	Friedman Test	df	*P*
DRS	Baseline	120.2	25.6	$\chi^2 = 9.27$	2	.01
	Intervention	123.1	25.7			
	Residual		120.2	27.7		
LMI	Baseline	22.8	19.1	$\chi^2 = 10.48$	2	.005
	Intervention	28.6	19.1			
	Residual		30.0	22.3		
LMII-TRS	Baseline	9.6	11.0	$\chi^2 = 19.39$	2	< .001
	Intervention	13.8	13.5			
	Residual		15.5	16.0		
MMSE	Baseline	24.9	6.15	$\chi^2 = 2.57$	2	.276
	Intervention	25.1	6.0			
	Residual		25.0	7.2		
LNS	Baseline	7.1	3.9	$\chi^2 = 5.30$	2	.07
	Intervention	7.8	3.9			
	Residual		7.6	4.2		

Abbreviations: DRS, Dementia Rating Scale; LMI, Logical Memory I; LMII-TRS, Logical Memory II–Total Recall Score; LNS, Letter−Number sequencing; MMSE, Mini-Mental Status Exam.
P = .05.

Efficacy of the ICSP

The Friedman test showed a difference over time for the DRS (*P* = .01), LMI (*P* = .005), and LMII (*P* < .001), scores for the treatment group (Table 4). No differences in scores were seen for the treatment or the control group on the MMSE (*P* = .276) and the LNS (*P* = .07).

Examination of changes in scores from baseline to intervention was completed with Wilcoxon Matched Pairs Signed Ranks Test (Table 5). These results indicated significant change in mean scores for the treatment group from baseline to intervention on the DRS (*P* = .001), LMI (*P* = .002), and LMII (*P* = .007). This was not the case for the control group. These results appear to indicate the ICSTP was effective in changing dementia scores, short-term and long-term memory, and delayed recall of auditory information.

To determine which group of participants had effected the change, pair-wise comparisons were completed (Table 6). Mean scores increased indicating an improvement on each outcome measure for each group, however, significance was present in only the mild and moderately impaired treatment groups on the DRS (mild and moderate *P* = .042) and the LMI (mild *P* = .042; moderate *P* = .048). Although none of the groups achieved a significance level <.05 on the LMII, the mildly cognitively impaired was the closest (*P*= .066).

Intervention to residual score pairs were analyzed to determine whether the treatment effect was sustained following the discontinuation of the ICSTP (Table 7). The results were nonsignificant for all groups, thus improvement in scores achieved with the ICSTP was maintained 8 weeks after the intervention had been discontinued.

Discussion

Findings of this study indicate that the ICSTP generally had positive effects on cognitive and memory functioning scores compared to a matched control group in individuals aged 65 years and above, and these effects were sustained with no additional treatment 8 weeks postintervention. No studies were found which report findings related to interventions blending pencil/paper-based activities and computer-assisted cognitive stimulation/training in a repeated measures design. Thus, intervention studies using either delivery format are discussed in relationship to the findings of this study to formulate insights.

Table 5. Pair-wise Comparisons of Baseline-intervention Outcome Variables for Control and Treatment Groups[a]

Variable			n	M	SD	Z	*P*
DRS							
	Control	Baseline	19	118.2	29.6	−.032	.975
		Intervention	17	123.0	28.6		
	Treatment	Baseline	15	117.7	25.5	−3.19	.001
		Intervention	15	124.5	22.5		
LMI							
	Control	Baseline	17	26.2	17.4	−.883	.377
		Intervention	17	28.2	20.0		
	Treatment	Baseline	15	20.3	21.2	−3.11	.002
		Intervention	15	30.1	18.5		
LMII-TRS							
	Control	Baseline	17	11.5	10.4	−2.23	.086
		Intervention	17	14.8	12.3		
	Treatment	Baseline	15	8.3	12.1	−2.71	.007
		Intervention	15	13.3	15.0		

Abbreviations: DRS, Dementia Rating Scale; LMI, Logical Memory I; LMII-TRS, Logical Memory II–Total Recall Score.
[a] Bonferroni correction used giving a revised significance level of $P = .017$.

Table 6. Pair-wise Comparisons of Preoutcome and Postoutcome Variables for Treatment Groups

Variable			n	M	SD	Z	*P*
DRS							
	Nonimpaired	Baseline	5	140.4	2.6	−1.60	.109
		Intervention	5	142.4	2.1		
	Mildly impaired	Baseline	5	126.4	5.4	−2.03	.042
		Intervention	5	134.0	2.9		
	Moderately impaired	Baseline	5	86.2	15.9	−2.02	.042
		Intervention	5	97.0	17.1		
LMI							
	Nonimpaired	Baseline	5	45.6	15.6	−1.36	.176
		Intervention	5	49.4	12.4		
	Mildly impaired	Baseline	5	12.8	6.7	−2.03	.042
		Intervention	5	26.6	11.0		
	Moderately impaired	Baseline	5	2.4	2.6	−2.02	.048
		Intervention	5	18.4	11.3		
LMII TRS							
	Non-	Baseline	5	22.6	11.3	−1.75	.080
	Impaired	Intervention	5	32.6	6.5		
	Mildly	Baseline	5	2.0	1.9	−1.84	.066
	Impaired	Intervention	5	6.2	4.3		
	Moderately	Baseline	5	.04	.89	−2.02	.317
	Impaired	Intervention	5	1.0	2.2		

Abbreviations: DRS, Dementia Rating Scale; LMI, Logical Memory I; LMII-TRS, Logical Memory II–Total Recall Score.
$P = 0.05$.

Table 7. Pair-wise Comparisons of Intervention-residual Outcome Variables

Variable			n	M	SD	Z	*P*
DRS							
	Treatment	Intervention	15	124.5	22.5	−2.16	.310
		Residual	15	121.5	24.3		
LMI							
	Treatment	Intervention	15	30.1	18.4	−1.89	.069
		Residual	15	26.2	20.6		
LMII-TRS							
	Treatment	Intervention	15	13.3	15.0	−.614	.539
		Residual	15	13.4	17.4		

Abbreviations: DRS, Dementia Rating Scale; LMI, Logical Memory I; LMII-TRS, Logical Memory II–Total Recall Score.
$P = 0.05$.

On mental status testing findings indicated no change in MMSE scores, however, the DRS scores improved from baseline to intervention and this change was maintained at residual testing 8 weeks later. The stability of MMSE scores may have stemmed from a ceiling effect for the nonimpaired group because these individuals achieved near perfect scores on the MMSE at baseline. The DRS is more sensitive in measuring cognitive changes and is less limited by ceiling or floor effects than the MMSE.[59,61]

Results of memory training and cognitive stimulation studies in older adults have been mixed. It is interesting to note that in the current study, which involved 3 levels of cognitive ability, when analyzing preintervention to postintervention scores it was the mildly and moderately impaired groups who achieved the most benefit. This finding is consistent with research reports indicating that participants with mild to severe cognitive impairment had significant improvement in mental status and memory following completion of programs using pencil and paper exercises, mental imagery, and multisensory stimulation to kindle encoding, consolidation, and retrieval of information and information processing.[62-64] Likewise, studies to examine the effectiveness of interactive computer-based memory training programs with mildly to moderately cognitively impaired participants found positive effects on specifically targeted domains of memory.[45,47]

The results of the current study are somewhat at odds with those using computer simulated personally familiar environments.[46,48] In these studies, cognitively impaired participants, although demonstrating markedly improved scores in training variables, psychometric testing of cognition or memory showed no significant changes over time. In these studies the samples may have been too small, duration of intervention too limited, or testing not sophisticated enough to note significant effect. Similarly, in noncomputer-based studies,[65,66] mildly impaired and participants with AD demonstrated no difference in global performance measures although the mildly impaired had significantly improved subjective appraisals of memory at the end of treatment.[65] The researchers note the studies were underpowered, each intervention session time was too long, and program length lacked sufficient duration. Likewise, in a large multisite trial (ACTIVE) memory impaired participants failed to benefit from memory training, but did show gains in cognitive skills of reasoning and processing speed.[43] These researchers questioned the suitability of the memory training used in the study to effect change in cognitively impaired individuals. The emphasis of the ICSTP was repetitive practice exercises rather than learning different cognitive strategies. This seems to have strengthened the personal strategies used by the participant to solve the presented activity which usually involved multiple cognitive processes (eg, logic and reasoning, embedded with memory stimulation).

Although the mean score increased slightly on the outcome measures of global cognitive functioning and memory for the nonimpaired group, the current study indicates the ICSTP has failed to replicate findings of previous research indicating these individuals significantly benefit from cognitive stimulation and training. Unlike the ICSTP, findings from a large, multisite, randomized clinical trial (ACTIVE)[33,34] indicated that memory, processing speed, and reasoning improved in nonimpaired participants as a result of training specifically targeting these skills with gains maintained at 2- and 5-year follow-up. In another study, 3 different memory improvement programs were examined in noncognitively impaired elders with findings on the Rivermead Behavioral Memory Test significant for computer-based memory training.[67] Likewise, Gunther et al[44] tested the impact on information processing speed, learning, and interference tendency in participants without dementia. Substantial improvements were present at completion of the training in all areas with cognitive improvements found to be significantly better 5 months after the end of training than before it started. Based on the concepts of brain plasticity, other researchers hypothesized that a training program could be specifically designed to reverse normal age-related losses in memory.[68] In their randomized controlled trial, a computer training program was implemented to engage normal mature adults in stimulus recognition, discrimination, sequencing, and memory tasks under conditions of close attentional control, high reward, and novelty. These authors report significant gains in assessments directly related to training tasks and neuropsychological measures of memory with sustained improvement after a 3-month no-contact follow-up period.

Possible reasons for the lack of benefit for the nonimpaired treatment group in the current study are important to note. Despite being the tools recommended in the scientific literature, the discriminating ability of the MMSE and DRS was not sufficient to note improvement in noncognitively impaired individuals. With this group using instruments designed to measure specific aspects of cognition may be more helpful, rather than the use of global cognitive function scales. Another plausible explanation was that the ICSTP intervention required a great deal of organization related to logistical issues (participation tolerance of the cognitively impaired, transportation, scheduled activities, appointments, etc) such that duration of the intervention was feasible for a limited period. Perhaps an increased number of treatment sessions would have created a different pattern in the results for the nonimpaired group. Similarly, although the nonimpaired participants acknowledged being challenged by the activities offered, conceivably content modification of some of the modules is needed to effect notable changes in cognitive function.

The ICSTP did not impact LNS scores for any of the treatment groups. The LNS scale was used to measure complex working memory which involves conscious attention to encoding and recall phases and the ability to specify the contingencies under consideration. Initially the LNS scale seemed like a useful tool, but perhaps it was not a suitable method for reflecting efficacy of any ICSTP influence made on complex working memory. Equally plausible, however, is that the ICSTP did not specifically teach strategies that required explicit, conscious associative linking. Mnemonic methods and rehearsal strategies are complex skills that must be learned first. The ICSTP provided practice exercises but did not provide formal instruction to learn new strategies.

Limitations

Several methodological limitations of the present study should be mentioned. First, the study included a small sample which limited its power, thus findings are only preliminary and do not allow generalization to other settings and populations. In addition, the sample was comprised mostly of females and all were Caucasian. Another consideration that may have minimized the effect size of the intervention was that the majority of the participants were highly educated (m= 14.1, SD 3.63). Ceiling effects were present in the non-impaired group relative to MMSE and DRS scores and reflect a methodological constraint. These issues pertinent to generalization are critical to address in future studies.

This study was a controlled experiment in that all participants were equally acquainted with the principal investigator and interventions and testing were provided in identical fashion. However, several control group participants were independent in their living situations and although instructed to continue their usual routine, a limitation of the study was the inability to manage or measure with accuracy the type and frequency of the participants' involvement in other cognitively stimulating activities. Likewise, each treatment participant was cognizant of receiving the intervention. This may have altered the results as an effect of receiving care, or creating stress related to the testing or the activities. These factors may have contributed to a participant's response.

Although the pair-wise comparisons of the intervention to residual scores on cognitive processes and memory (DRS, LMI, and LMII) indicated the durability of the ICSTP effect after 8 weeks of no contact, the trend was a decrease in mean scores. Thus, questions remain, for example: at what point will the effect become nonevident; would an increase in the duration of the intervention make a difference; and, would additional strategies such as homework assignments or booster sessions provide for maintained efficacy?

For researchers who blend computer platforms and traditional cognitive stimulation/training the challenges ahead lie in examining efficacy in larger controlled trials to ascertain transportability to community, primary care, and nontraditional settings where elders seek disease management and wellness programs. Additionally, further development of ecologically valid cognitive stimulation and training programs is needed to assist individuals with real world tasks. Another consideration is related to designing computer programs to integrate geriatric "user friendly" design features and learning style preferences. Although not all psychometric tests showed significant effects with regard to specific aspects of cognitive performance and these results are preliminary, levels of motivation were high and there was a positive acceptance of the ICSTP and signs of emotional activation. Indications are that incorporating interactive computer-based programs may add encouragement for proactive involvement in activities to preserve cognitive function.

In conclusion, this investigation supports the view that similar to noncognitively impaired those with mild cognitive impairment and dementia can learn, and maintain cognitive and functional abilities. Additionally, the positive findings add support to the idea that consistent stimulation of memory, language, attention, and other cognitive skills can potentially be useful for slowing cognitive decline associated with aging and with a dementing disease process. There is currently no pharmacological treatment that has proven effective in prevention or curing dementia, thus, cognitive stimulation techniques, which present no toxic effects, must continue to be researched for their possible preventative and palliative therapeutic value. The extent to which the ICSTP could prolong cognitive and functional gains in the elderly remains an empirical question and these preliminary results await confirmation and clarification in the course of further study.

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